ACORN USER

BBC micro, Electron and Atom magazine

May 1983 £1

GRAPHICS: mixing colours
SCHOOLS: language work
PRINTERS: the easy way
BBC: new OS details
ATOM: sound board
BBC: new Basic



MUSIC: folk, jazz blues on a BBC micro



DIY interface box for the Beeb

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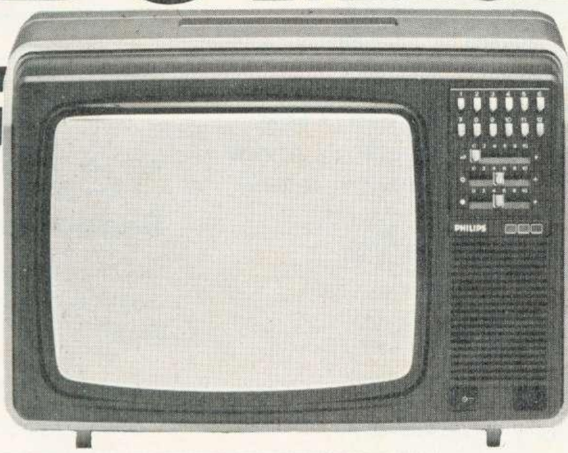
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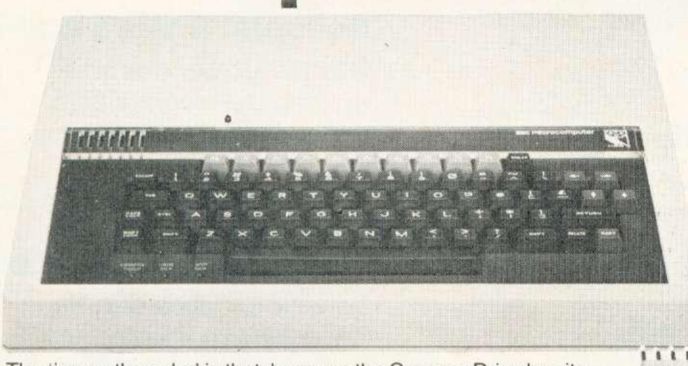
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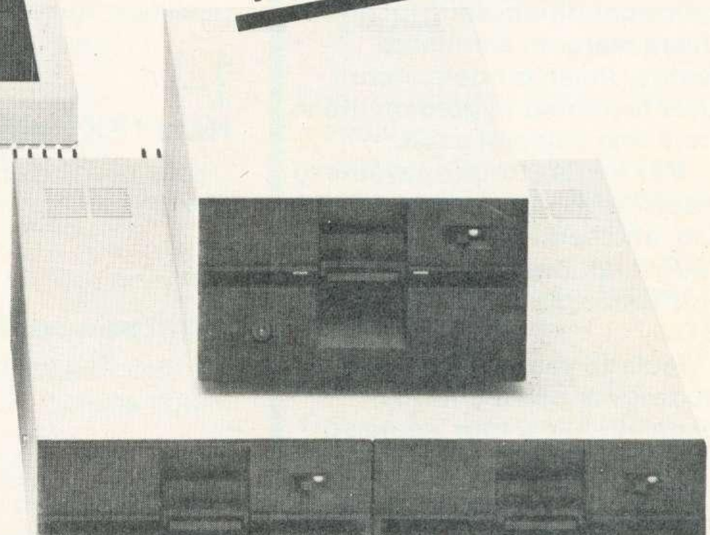


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Coming soon in *Acorn User*:

New series: Introduction to programming techniques

Schools: Information technology and syllabus

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Interfacing: Using this month's DIY project

Electron: We're going to get one!



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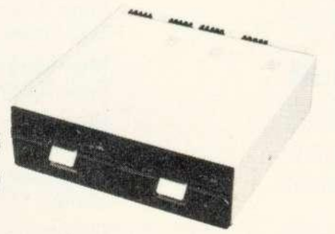
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Summer launch for Electron



Acorn's Electron – the first picture to be printed

EXCLUSIVE

JUNE is the date set for full-scale production of Acorn's new £150 home computer – the Electron.

A major feature of the machine is that its language is BBC Basic, which means it will run most software written for the BBC micro.

Memory provided is the same as the model B – 32k ROM and 32k RAM. The Basic interpreter also includes the BBC machine's powerful 6502 assembler.

As revealed in last October's *Acorn User*, all the Electron's keys will be programmable. Ten are set aside as function keys, while 29 provide single key entry for Basic commands such as CHAIN, LIST, etc. The caps lock key doubles as a function shift to control the programmable keys.

The Electron is really a 'chopped down' BBC micro – and this is reflected in the fact that its processing speed is slower, it does not support the mode 7 screen, has only one sound channel and few interfaces. The changes to BBC Basic are to allow for these hardware differences.

However, a range of add-on modules are planned to provide disc and printer interfaces (Centronics and RS232), the Econet networking system, the Tube for running second processors, the 1 MHz bus interface, teletext, Prestel, and speech synthesis.

Cassette input is at 1200 baud, and outputs are provided for colour television through the standard aerial socket, composite video, and PAL or RGB monitors.

Power to the Electron comes through a separate transformer which is provided with the machine.

The Electron's casing measures 330x160x50mm, which is about the same width and height as the BBC micro, but less deep. It is, however, a lot stronger than the Beeb's and the same colour. The grid strip on the casing is brown, with cream lettering and green acorn – very Habitat!

The 6502 microprocessor runs at 2MHz (same as the BBC micro) and a real-time clock is included. The major speed difference will be seen in the high resolution graphics modes (0 to 3). In other display modes the Electron will run at about two-thirds the speed of a BBC micro.

An American TV standard version will undoubtedly be produced. However, Acorn is waiting to see how the BBC micro goes down across the Atlantic first. The Beeb has been modified and is already being tested in the US to meet their safety standards. So far it has been well received in their computer press (see for example *Computing and Electronics*, March issue).

The Electron will be built in Singapore, unlike the BBC micro which is mainly from Britain with overseas sales provided from the Far East.

BBC to get tough over logo misuse

THE BBC has hit out at companies which misuse its logo and is prepared to take legal action to stop the worst offenders.

In letters to computing magazines and advertisers the Corporation warns that use of its logo (the letters BBC inside their distinctive rhomboids) is infringement of copyright and that 'the BBC is not prepared to allow such use'.

BBC solicitor Tom Rivers told *Acorn User* companies had so far been co-operative although he had received no reply from one major culprit. But Mr Rivers was adamant about the BBC's intent to stamp out abuse. 'I am going to stop it', he declared.

This action has been prompted by concern within the BBC that use of its logo implies products have been licensed by the Corporation. However, in most cases this is not so, the letters point out. The BBC feels 'the quality of the products is not acceptable' and is 'keen to impose some form of quality control on the market'.

Application for permission to use the logo should be made to BBC Enterprises.

Entry discount to subscribers

SUBSCRIBERS to *Acorn User* will receive a special £1 discount on entrance to the Acorn User Exhibition in August.

Vouchers to be inserted in a future copy of the magazine will give £1 off the entry fee (adults £2, children £1).

Only one voucher will be issued per subscription, and these will be collected at the door.

The Exhibition is set to provide the first major appearance of the new Acorn Electron, Second Processors and Teletext adaptors.

Bulk discounts on tickets are available to schools for the Exhibition which runs from Thursday August 25 to Sunday 28.

Details from Acorn User Exhibition, 20 Orange St, London WC2H 7ED.



Help with Quest

GOOD news for anyone who keeps getting trampled on by elephants in Philosopher's Quest – Acornsoft has released a book of jumbled hints and answers.

The eight page leaflet covers the most popular questions and replaces the old postcard for clues. It is sent to anyone who needs help.

Acornsoft are due to release seven new packs this month – three on chemistry, a programming package called *Microtext, Draughts* and *Reversi, Starship Command* (see reviews) and another adventure – *Countdown to Doom.*

Acorn means business with '£2000 system'

Hauser says, ABM is only months away as Z80-program pack is finalised

ACORN is planning to go into business in a big way this year.

Hermann Hauser, joint managing director, told *Acorn User* the company will 'launch a business machine this year for under £2000.'

'The Acorn Business Machine will be based on a BBC micro with Z80 Second Processor' said Hauser. 'It will include two disc drives, integral TV screen and communication facilities – Econet as well as links to the telephone system.'

The expertise and technology to build the ABM has long been available within Acorn, says Hauser. 'It is merely a matter of packaging.'

Meanwhile, Acorn is finalising the CP/M software package for release with the £295 Z80 Second Processor – as revealed in last month's issue.

'The software is aimed at the small business and gives great value for money,' said a spokesman.

'It is pitched at the right level for an introduction to business computing, but expands to give entry to more sophisticated techniques.'

The package covers accounting, productivity and programming. Acorn claims to have 'scoured the world for good software', and to be dealing with market leaders in each sector.

Buying British was one of the original aims, but, says Acorn, software houses were unable to provide the



sort of integrated systems needed.

Reliability checks are being stepped up on the BBC micro now Acorn has two years' experience on the machine. A redesign is also being made to reduce the number of components which will in turn reduce the possibility of things going wrong.

Recent checks were made on the machine's packaging and involved throwing it down the stairs at the company's HQ!

The customer service department has been expanded and Acorn now plan to virtually double their office space to meet expansion in this and other departments.



Cassette microdrive for Beeb

IF YOU CAN'T afford a disc drive and interface, but cassettes drive you insane, the Hobbit could be the answer.

The Hobbit is an automatic digital cassette recorder (rather than acoustic) which plugs into the user port of the BBC micro and is ready to go for £135 plus VAT. It is claimed to be almost as good as a disc system – at half the price. It is up to seven times faster than a normal cassette.

Hobbit uses tiny cassettes, similar to those used by dictating machines, each with a capacity of 60k per side (disc capacity is 100k for single-sided, single-density). Like discs, cassettes are formatted for easy information retrieval.

An EPROM operating system is supplied which is plugged into a sideways ROM socket alongside the BBC operating system and Basic – the manual gives full instructions. If the thought of fitting the EPROM is too much, the makers, Ikon Computer Products, will fit it.

Existing files or programs can be copied from normal cassettes onto the Hobbit either for back-up or to load your favourite games that much faster.

Ikon claim the Hobbit is compatible with all versions of the Beeb operating system and it comes with its own leads and cables.

Further details are available from Ikon Computer Products, Kiln Lake, Laugharne, Carmarthen, Dyfed. Tel: (099 421) 515.

Hi-res telly

ELECTRONEQUIP have announced a new 14" TV/monitor which, they say, has better resolution than most other receiver/monitors. It is not a modified TV but a purpose-built unit which can accept RGB or normal TV input. There is also a separate sound input. It costs £210 + VAT. Details from Electronequip, 36–38 West Street, Fareham, Hants. Tel: 0329 230670.

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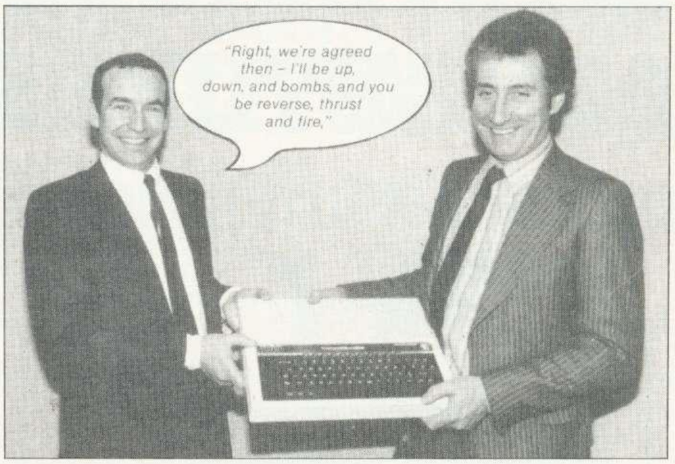
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BBC programme goes live

Following the success of their latest series 'Making the Most of the Micro' the BBC are planning to put on a live computer programme. The BBC are inviting comments and queries in the series from viewers with and without machines.

The live show will go out on BBC1 on Sunday October 2nd from 11am to 12.55pm with a studio audience. The show will be headed by Ian McNaught-Davis with a panel of experts, including Acorn's John Coll, to answer queries.

If you would like to join the studio audience or put your comments, ideas or questions, write to Micro Special, P.O. Box 7, London W3 6XJ giving your name and daytime phone number.



March competition winners

Our winning caption came from Mr P.L. Callan of Oldham, Lancs. Runners up were Mr T. Tugwell of Northampton, Thomas Perry of Barking, J. Olive of Basingstoke and Matthew Healy of Walsall.

We had over 400 entries to our other March competition to find the hidden message. The first correct entry received was from Mr R.B. Hargreaves of Stockport who receives a free subscription. A runners-up prize goes to Ian D. Fildes of Vancouver who sent in his reply by telegram as well as post card! For those still guessing, the message was in morse code on pages 12 and 13 and read 'Checkmate checkmate ha ha'.

Concern in Commons over Computer Education

Education Secretary Sir Keith Joseph's proposals unveiled in a government White Paper, 'Teaching Quality' have one gaping hole . . . there is no mention of computers. The failure to include any reference to computer studies or the proper use of computers in teaching came despite growing Commons criticism that teachers are too often handicapped by inadequate training or lack of suitable software.

The White Paper looks at ways teacher training could be improved and the need for practical experience. But nowhere, throughout the 35-page document, is attention focused on equipping teachers to use micros, either for computer studies or as a teaching aids.

Liberal education spokesman Alan Beith MP describes the White Paper's omission as "very surprising." It was a view echoed by Labour's information technology spokesman John Garrett MP.

Down at the Department of Education and Science it was being pointed out how part of the package to put a micro into every school involves sending two teachers from each secondary school on a special course.

special course. How far this will take the total novice though might be debatable – for the course lasts just four days. Meanwhile many primary schoolteachers are finding themselves with a "Do-It-Yourself" course and a step-by-step manual.

DoI recommends Acorn Econet

The Department of Industry and the Manpower Services Commission have recommended the Acorn Econet for their two hundred Information Technology Centres.

Acorn say that nearly a quarter of the 12,000 BBC micros they sell each month are equipped with Econet interfaces. Most of these go to the education market but other customers include British Telecom, the DHSS, National Physical Laboratories and Gas Boards. As typical networks have around 10 machines, this means that around 250 networking systems are being set up each month.

Software Sales Overseas

British software, as well as British micros, is growing in popularity overseas. One education software house, Chalksoft of Somerset has just announced distributorship for its home and school software for the BBC micro in Australia and Africa. Deals are also pending for several countries in Europe. This is just one more in the increasing number of software companies joining the export drive.

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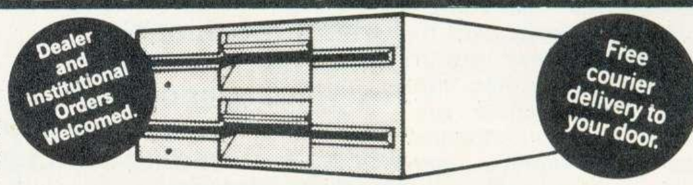
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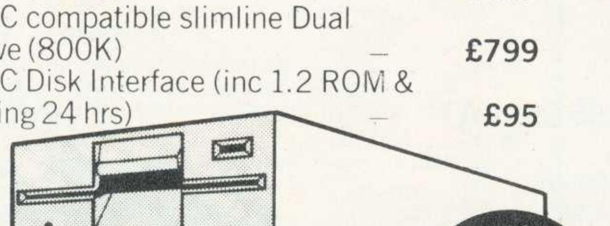
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LOW-DOWN ON NEW BASIC

Despite doubts aired about its existence in some magazines, Acorn has released a second BBC Basic. The differences are, however, minor. Here, Paul Beverley covers the major changes.

IN, the new version of Basic, Acorn's programmers have put right a number of rather obscure errors they discovered in Basic I, and have also added some features. Most of the errors are fairly obscure, and will not even have been noticed.

Apart from the errors which have been corrected, the LN and LOG functions have been recoded to make them more accurate.

The new functions include OSCLI, which stands for operating system command line interpreter. The idea is that from Basic it is impossible to use a command line that contains a Basic variable. For example, you cannot say *FX5,X% where X% has some particular value. This is because as soon as Basic meets the * it passes the whole of the rest of the line to the command line interpreter, and the command line interpreter does not understand X% since it is a Basic variable. You cannot even say:

```
*FX5,2 : REM Serial printer
```

as the colon is specific to Basic.

What OSCLI does then is to say pass the string which follows (in brackets) to the command line interpreter. The examples below shows how to use OSCLI with a variable by turning the variable into a string, concatenating it with the rest of the command, and then passing them to the command line interpreter.

The second useful new feature is the keyword OPENUP, for updating disc files. Previously, the file had to be opened using OPENIN to read data from it, and then closed, before it could again be opened using OPENOUT to write to it. To read more data, the file had to be closed and re-opened again using OPENIN. This made random access filing tedious and slow.

OPENUP allows users to read and write to the same file without having to close it and re-open it every time. Program 1 creates a file using OPENOUT and allows you to look at individual items of data and change them.

However, OPENUP cannot extend a file. The way to do that is to OPENIN the file, OPENOUT another filename, and copy it all across the old file to new and add the extra data.

The third feature is handy for putting machine code programs in EPROM in the sideways ROM sockets. The idea is that when assembling a machine code program you continue to use P% as the program counter but use O% to specify where the code should be stored. For example, suppose you want to assemble code for use in a sideways ROM at &8000 and you want to put the code temporarily at memory location &3000 upwards from where it can be transferred into the EPROM. You will need to set O% = &3000, but P% should be set as &8000 – the actual execution address of the code.

To make this compatible with the original arrangement (where P% was used for both the program counter and the origin at which the code was to be stored), OPT is used. The first two bits of the OPT command (ie OPT 0–3) determine whether a listing is produced and/or errors are reported. The third bit is now used to determine whether O% and P% are separate (if the bit is set to 1) or linked (if the bit is cleared to 0). Thus OPTs 0–3 work as before with P% acting as program counter and origin, while OPTs 4–7 should be used when the code is to be stored at a place other than where it is to be executed.

Program 2 illustrates this. Using OPTs '4 TO 7 STEP 3' gives the two pass assembly with listing and errors reported only on the second pass. As the program is assembled, the addresses used are in the &8000 range, but if you examine memory locations &3000 onwards, you will find the assembled codes.

● The new Basic ROM is already going out in machines and will be available from dealers. To discover which you have, type REPORT. A copyright line will result. BBC Basic II is dated 1982.

```
 10 X = OPENOUT("DATA")
 20 FOR N% = 1 TO 100
 30   PRINT# X, N%
 40   NEXT
 50 CLOSE# X
 60
 70 X = OPENUP("DATA")
 80 REPEAT
 90   INPUT "Number of data item to be changed", N%
100   IF N% = 0 GOTO170
110   PTR# X = (N% - 1) * 5 :
      REM Set pointer to data item
120   INPUT# X, R% :
      REM Pointer moves on by five bytes
130   PTR# X = PTR# X - 5 :
      REM So move pointer back by five bytes
140   PRINT"The current value is "; R%
150   INPUT "New value", D%
160   PRINT# X, D%
170   UNTIL N% = 0
180 CLOSE# X
190 END
```

Program 1. Creates file using OPENOUT

```
INPUT "Serial or Parallel Printer", A$
IF ASC(A$) = 80 THEN X% = 1 ELSE X% = 2
OSCLI("FX 5," + STR$(X%))
```

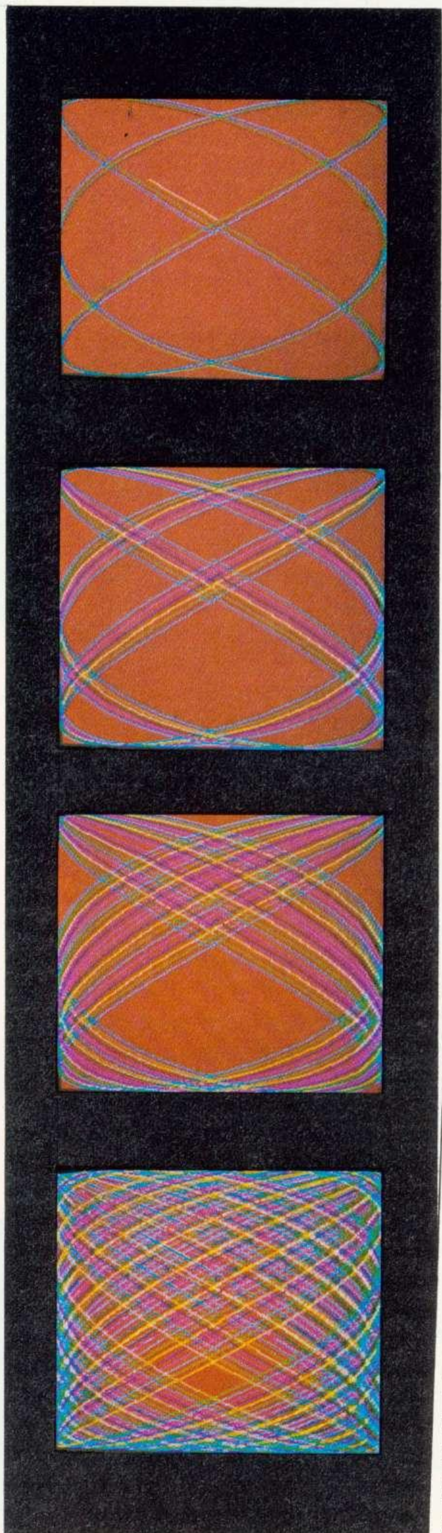
```
 10 DIM CODE 100
 20 FOR N% = 4 TO 7 STEP 3
 30   O% = CODE
 40   P% = &8000
 50   [ OPT N%
 60   .start
 70   LDA# 33
 80   JSR &FFEE
 90   JMP start
100   \ etc
110   ]
120   NEXT N%
```

```
>RUN
8000             OPT N%
8000             .start
8000 A9 21       LDA# 33
8002 20 EE FF    JSR &FFEE
8005 4C 00 80    JMP start
8008             \ etc

   >P. ~ ? &3000
           A9
   >P. ~ ? &3000
           21
   >P. ~ ? &3000
           20
```

Program 2. Uses temporary memory location

LOOPY GRAPHICS



Photos: Pam Fish

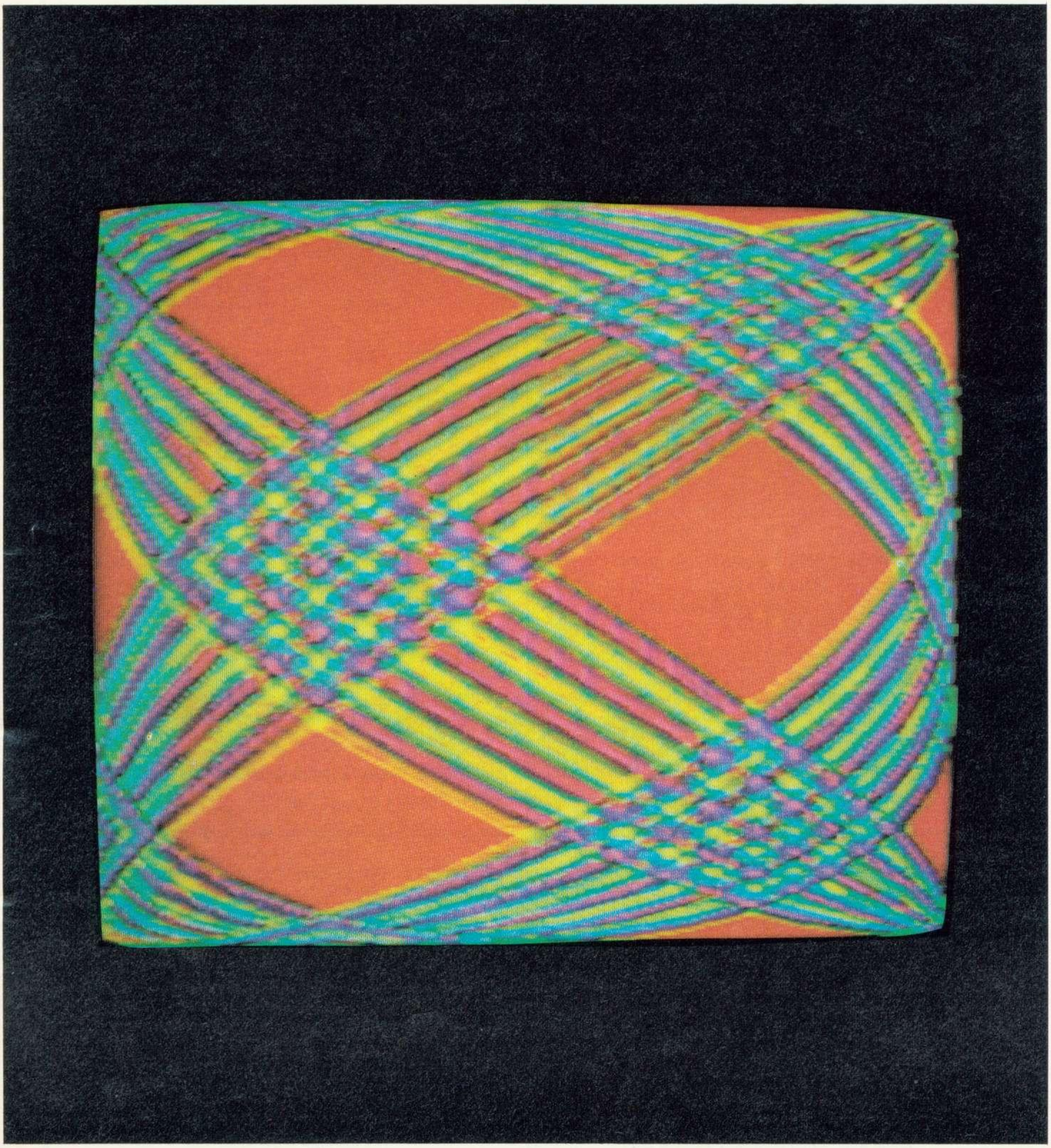
THIS short program by Tim Fish for the BBC micro produces the well-known Lissajou figures in mode 2. Type in the listing, type RUN and press return. The program then asks you to input a phase number. Numbers which are simple divisors of 360, eg 45, 90, 180, 270, will produce simple patterns. Values slightly higher than these, eg 271, 180.2 are most attractive.

As listed it will run on a BBC model B. For model A change mode 2 to mode 5 at the start of line 130 and change line 250 to:

c=c+1:IF c=4 THEN c=1

Pressing any key will stop the display, except R which will restart the pattern.

```
 10  REM  ** Lissajou **
 20  REM  ** (c) Tim Fish **
 30 MODE6:IFC%=-1THEN40ELSEPROCCPYRT:C%=-1
 40 c=1:CLS:C=0:COLOUR128
 50 PRINT"Enter Phase (0-360)";
 60 INPUTDY:IFDY<0ORDY>360THENPRINT"0-360"
:GOTO60
 70 B=RND(6)
 80 DY=DY/360
 90 C=C+1:IFDY*C-INT(DY*C)>.1THEN90
100 CX=0:CY=0:DX=1:c=RND(6):IFc=B THEN100
110  REM **Change to Mode 5 next line**
120  REM  **if you have a model A**
130 MODE2:MOVE640,512:VDU19,0,8,0,0,0
140 GCOL0,c
150 VDU23,1,0;0;0;0;
160 VDU29,640;512;
170 FORRPT=1TOC
180    FORCX=8TO360STEP8:CY=CY+DY*8
190      X=SIN(RAD(CX))*639:Y=SIN(RAD(CY)
)*511
200      DRAW X,Y
210      IFINKEY(0)<>-1THENIFGET$="R"
THENRUN
220      NEXT:NEXT
230  REM **Change next line for model A**
240  REM **to read "c=c+1:IFc=4THENc=1"**
250 c=c+1:IFc=7THENc=1
260 IFc=B THEN250
270 GCOL0,c
280 GOTO170
290 IFGET<>-1THEN40
300 DEFPROCCPYRT
310 PRINTTAB(0,24)"Press any key";:x=GET
320 ENDPROC
```



NEW *FX CALLS

THIS list of *FX/OSBYTE calls reached *Acorn User* from Acorn. Most are undocumented in the BBC micro *User Guide* (page 501) and are all implemented in the Series One operating system.

Decimal	Hex(&)	Function
*FX 13	0D	Two parameters may be supplied in X to *disable* events (*User Guide* p465): X = 7 disable RS423 receive error event X = 8 disable service/network error event
*FX 14	0E	As above, but parameters *enable* events
*FX 117	75	Returns the VDU status byte (which contains various status flags in the X register. Bit 0 – set if VDU2 sent, cleared by VDU3 Bit 2 – set if paged mode on, cleared if off Bit 3 – set if software scrolling, cleared if hardware scrolling Software scrolling is used when text windows have been defined whereas hardware scrolls are used when the whole screen scrolls Bit 5 – set when cursors joined by VDU5 Bit 7 – set if VDU disabled
*FX 118	76	Returns with the carry bit set if the CTRL key is pressed, and with the negative bit set if the SHIFT key is pressed. Machine code routines may branch on these conditions.
*FX 123	7B	This call is used by the user print routine to indicate to the MOS it has finished its task (cf *FX 5,3 command).
*FX 138	8A	This call has been expanded to allow a character to be inserted into any buffer. X must contain the buffer number, and Y the character to be inserted. A list of buffer numbers appears with *FX 21 (*User Guide* p428).
*FX 141	8D	Exactly equivalent to *ROM
*FX 152	98	This call examines a buffer. The buffer number must be in X, and the call returns as follows: Carry bit set if buffer empty Carry bit clear indicates character(s) present in buffer. Y contains the next character which will be returned if the buffer is read. Character in Y has not actually been removed from the buffer).
*FX 153	99	Inserts a character into an input buffer handling the interrupt character, generating an escape condition if necessary. Valid only for X = 0 or 1. Y must contain character to be inserted.
*FX 156	9C	Change 6850 control register. The 6850 is altered to: (Old value AND Y) EOR X (*User Guide* p438). Refer to 6850 data sheet.
*FX 158	9E	Respectively read and write to the speech
*FX 159	9F	processor chip.
*FX 233	E9	As for &E7 (*User Guide* p441) but affects the system 6522. The system 6522 is used extensively in the normal operation of the micro. *This call should be used with extreme care.*
*FX 235	EB	Return presence of speech processor: X = &FF if present, &00 if not.
*FX 241	F1	Read/Write *FX 1 value (*User Guide* p438)
*FX 245	F5	Read/Write *FX 5 value (*User Guide* p438)
*FX 246	F6	Read/Write *FX 6 value (*User Guide* p438)
*FX 252	FC	Reads identity of current language (a number from 0 to 15). This indicates which socket the presently selected language ROM is in. The sockets are numbered from right to left starting at 15. On board sockets are 15, 14, 13 and 12: the remainder can be installed offboard.
*FX 253	FD	Returns a number indicating what sort of reset last occurred: 0 = soft break; 1 = power-on break; 2 = CTRL break
*FX 254	FE	Read/Write RAM: 128 = 32k, 64 = 16k
*FX 255	FF	Read/Write start-up option byte. This allows the keyboard link value to be read. It may be written to, but the value will be reset to the actual wired value on any reset other than a soft-reseet. The links are configured as follows: 1 2 3 4 5 6 7 8 X D_2 D_1 B M_3 M_2 M_1 D_2, D_1 : disc configuation bits (see Disc Manual) B : auto-boot select (auto-boot when fitted) M_3, M_2, M_1 : screen mode on hard reset (0–7) X : unused




HINTS AND TIPS

Joe Telford builds a lightpen for £17 and writes the software to run it on the BBC micro – with or without the Tube

SHINE A LIGHT

Joe Telford corrects his design in March's Acorn User, and explains how to use the pin photodiode and Schmitt receiver

LIGHTPEN CHANGES

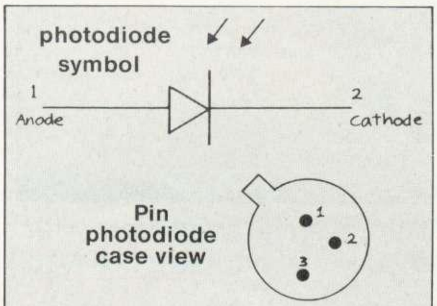


Figure 1.

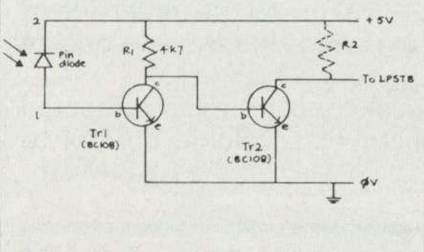


Figure 2. Circuit diagram

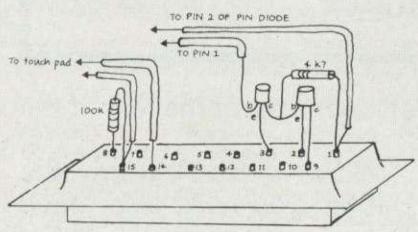


Figure 3. Component construction

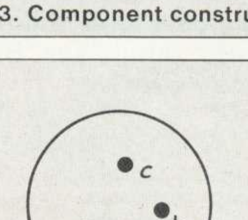


Figure 4. BC108 pinout

THE lightpen article in the March issue of *Acorn User* caused a good deal of comment. The final circuit shown incorporated a pin photodiode which does not operate in the circuit given – although a few minor alterations allow it to do so.

Adventures with the lightpen began back in September, and the initial circuit relied on the photodiode. However, to improve on development time, and cut down the component count, the later circuit used a different device – the Schmitt receiver, RS part number 303 270. Unfortunately, the final text was written five months later, and unwittingly referred to the incorrect device.

For readers who have not invested in the lightpen yet and wish to do so, the simplest approach is to use the Schmitt receiver, in the March circuit as the pin numbers are exactly compatible. For readers having difficulty ordering from RS, most High Street TV repair/hi-fi shops can order it.

If you have bought a pin photodiode, there is no need to worry, because for an extra 50p or so, it will work.

Figure 1 shows the pin photodiode as an electronic symbol and from the viewpoint of the casing connections. If we connect pin 2 to +5V, the diode will conduct when illuminated. It has an extremely fast response time, but the TV screen is not bright enough to give a pulse the CRTC can detect. We need to amplify the pulse from the pin photodiode. Probably the easiest approach is to use a couple of transistors to provide the necessary signal. Figure 2 is such a circuit suggested by Mr M. Lee of Cheshire.

Tr2 is normally conducting because its base is held at +5V by resistor 1. This means the full 5V is developed across R2, a resistance normally tying LPSTB on the CRTC to +5V. This effectively means that the LPSTB input is pulled to 0 when the diode isn't illuminated. Once the diode is illuminated by a TV screen, it will begin conducting, and hence Tr1 will turn on. This places zero potential on the collector of Tr1, which effectively switches off Tr2. The LPSTB input is then pulled back to 5V.

This change of state can be detected by the CRTC and the software provided in the March issue will calculate the position of the pen on the screen, although the offset values may vary because of the components used, and readers may find a little experimentation necessary, though Mr Lee has found that three such pens have worked perfectly. The normal approach to adding extra components would be to include them in an interfacing box, but they are small enough to be mounted directly onto the D connector.

Readers wishing to do this may find figures 3 and 4 useful, but should remember that too much heat will destroy the transistors. In addition, the leads may need to be protected against shorting, especially if the connector cover is metallic. Figure 4 is the pinout of the BC108 transistor Mr Lee has used.

The final connection to the pin photodiode is shown in figure 3 and readers must remember to connect pin 2 of the diode to +5V and pin 1 to the base of Tr1.

Assuming the photodiode is already available the extra components needed are: R1, 4k7 resistor ⅛th watt 10%, about 5p; Tr1, Tr2 BC108 transistors, 20p each.

The circuit will react to the brightness of the TV screen which may need adjusting. Mr. Lee has found the accuracy of his circuit to be approximately plus or minus one pixel, and so amending program 3 in the March issue by changing line 40 to:

```
40 x=20:y=15
```

will help set the accuracy of the pen, which is partly dependant on brightness.

Our thanks to dealers and RS Components for handling enquiries about the March article.

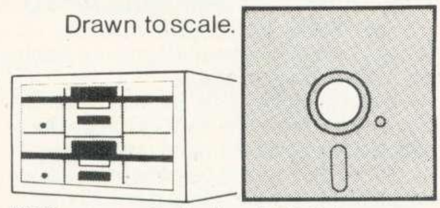
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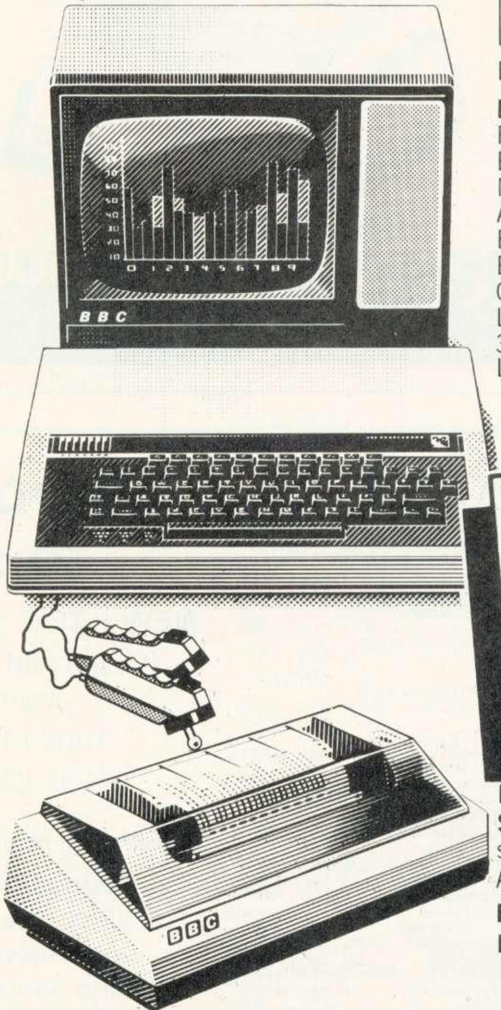
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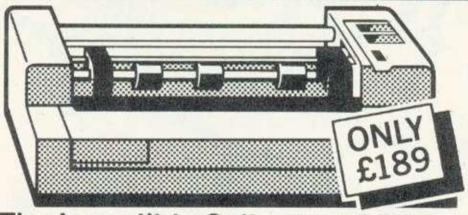
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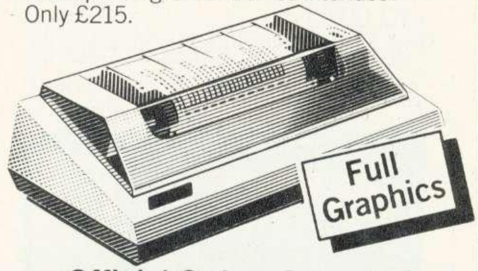
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Peter Voke explains how to get more colours out of your BBC micro. . .

A SHADE MORE COLOURFUL

If you think the model A BBC micro can only display eight different colours, with a maximum of four at one time, read on. Forty distinct shades would be nearer the mark, with more than a dozen displayed simultaneously. Mode 2 on a model B can put all these hues on the screen at once.

But how is it done? The usual technique is to put bytes directly into that part of memory storing the picture. However, it is not the best way, for these reasons:

- putting bytes one by one into memory ('poking') is slow and inefficient,
- screen memory locations vary between modes and are different in models A and B,
- the numbers put into memory are related to the colours in a complex way (more about these below),
- people using television sets may find annoying stripes running diagonally across colours, similar to radio interference,
- programs using direct memory addressing will run into big trouble with expanded systems.

A different method to poking is demonstrated by the photo program on the *Welcome* cassette, although it does not hint at how many colours could be present. For large areas, the principle is simple: generate a new shade by mixing existing colours (black, red, green, yellow, blue, magenta, cyan, white) on alternate horizontal lines. For instance, alternating lines of red and yellow will give a convincing orange, while red and magenta give bright pink. Type in and run program 1 to see the range. Model B owners can use program 2 which puts all the shades on the screen simultaneously. This is by far the best method of getting mixed colours on a TV display.

There are a number of points about these programs. *TV 0,1 in line 100 resets the vertical position of the display and turns off the interlace. This makes the new colours steadier (at least on my TV), and gives a wider range of mixtures. To reset the position and interlace, use *TV X,0 (with X= 0 or 1 or 255 (*User Guide* pages 23, 435).

STEP 8 in lines 170 and 220 is crucial. The vertical resolution (number of distinct horizontal lines on the screen) is 256 'pixels' in all graphics modes (0, 1, 2, 4 and 5) even though the *Y* coordinates run from 0 to 1023. This means that plotting a point at coordinates 100,100 (PLOT69,100,100) followed by another at 100,101 is a waste of time, since both points lie inside the same pixel, which has a vertical spread of *Y* coordinates from 100 to 103. So PLOT69,100,Y commands with Y = 100, 101, 102, or 103, all affect the same pixel, the 25th from the bottom, since 100/4=25.

Don't attempt to fill the screen with orange by plotting alternate red and yellow lines at Y= 0,1,2,3, and so on; use Y = 0,4,8,12,16 hitting a new set of pixels each time. One colour goes at Y = 0,8,16 . . . and the other at 4,12,20. . .

To construct a particular colour generated in program 1 or 2, you need to know which underlying colours it is made from. In both programs the underlying pure colours occur on the diagonal running from bottom left to top right of the rectangle. Each mixture is obtained by alternating the underlying colour in the same row with the one in the same column as the mixture. For example, check

page 22▶

```
>L.
   10*************************************
   20
   30REM "COLOURS 4"
   40REM DEMONSTRATES COLOUR MIXTURES
   50REM IN 4-COLOUR MODES.
   60REM PETER VOKE  1982
   70
   80*************************************
   90
  100*TV0,1
  110*FX11,0
  120MODE 7
  130IFHIMEM>&6000THENMODE1 ELSEMODE5
  140VP%=100:HP%=0:VDU23;8202;0;0;0;
  150
  160FOR C%=0 TO 3:GCOL 0,C%
  170FOR V%=VP% TO VP%+188 STEP 8
  180MOVE 0,V%:PLOT1,1280,0:NEXT
  190VP%=VP%+192:NEXT
  200
  210FOR C%=0 TO 3:GCOL0,C%
  220FORV%=104 TO 868 STEP 8
  230MOVE HP%,V%:PLOT1,319,0:NEXT
  240HP%=HP%+320:NEXT
  250
  260PRINT TAB(0,1)"PRESS RETURN"
  270PRINT "FOR NEW COLOURS"
  280FOR I%=0 TO4:FOR J%=I%+1 TO 5
  290FOR K%=J%+1 TO 6:FOR L%=K%+1 TO 7
  300A=GET:VDU19,0,I%;0;19,1,J%;0;
  310VDU19,2,K%;0;19,3,L%;0;
  320NEXT:NEXT:NEXT:NEXT:A=GET
  330
  340CLS:PRINT TAB(6,4) "FINISHED"
  350A=GET:CLS:VDU20:*FX12,0
  360END
```

Program 1. Colours for model A

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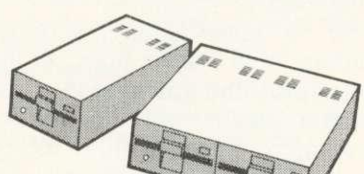
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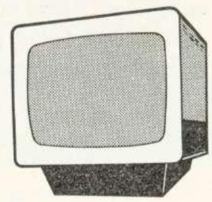
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▶ *page 19*

that orange is made up of red and yellow. With a mixture of yellow and black, or blue and white, the strips of the two colours running horizontally can be clearly seen. To get a particular range of shades, first select the appropriate palette of pure underlying colours using VDU19 commands (*Acorn User*, July/August, page 7, *User Guide* page 382); then use those colours, in pairs on alternate lines, to produce the mixtures. Model B owners using mode 2 will not need VDU 19 since all eight pure colours are available anyway.

This brings out an important point. On some TV displays there is a distinct difference between shades produced by programs 1 or 2 that are opposite each other (top left to bottom right) and hence are made up of the same underlying

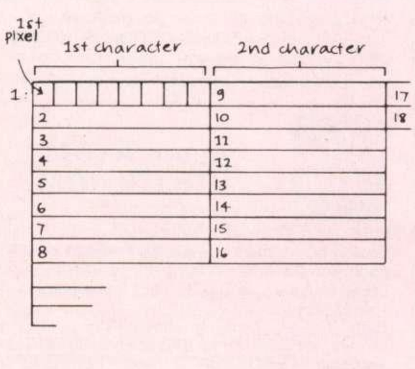


Figure 1. Order of strips of screen

colours. (This does not work on a monitor or with interlace off.) For instance when red and green are the underlying colours, the two mixtures can look utterly different, one being bluish, the other khaki, with interlace off. The reason is that the appearance of an underlying colour depends on precisely where the lines are plotted on the screen, which in turn depends on when the program starts relative to the TV's vertical synchronisation. If program 1 or 2 is run several times, the two different mixtures of red and green (say) change places in a random way from one run to the next.

In one sense this is a bonus since it gives still more subtle hues, but it is important to remember that the precise appearance of these colours cannot be predicted. In many situations this may be an advantage. Program 3 is another

```
10*********************************
20
30REM "COLOURS 16"
40REM DEMONSTRATES COLOUR MIXTURES
50REM IN 16 COLOUR MODE (MODE 2).
60REM PETER VOKE 1982
70
80*********************************
90
100*TV0,1
110*FX11,0
120MODE 2:VP%=200:HP%=160
130VDU23;8202;0;0;0;:REM CURSOR OFF.
140
150FOR C%=1 TO 7:GCOL 0,C%
160FOR V%=VP% TO VP%+88 STEP 8
170MOVE 0,V%:PLOT1,1280,0:NEXT
180VP%=VP%+96:NEXT
190
200FOR C%=1 TO 7:GCOL0,C%
210FORV%=100 TO 868 STEP 8
220MOVE HP%,V%:PLOT1,159,0:NEXT
230HP%=HP%+160:NEXT
240
250PRINT TAB(0,1) "PRESS RETURN"
260PRINT "FOR FLASHING COLOURS"
270VDU23;8202;0;0;0;:REM CURSOR!ONFF.
280FOR I%=1 TO 7:*FX15,1
290A=GET:VDU19,I%,I%+8;0;:NEXT
300
310COLOUR 4:A=GET:*FX10,0
320PRINT TAB(6,1) "FINISHED":A=GET
330CLS:VDU20:*FX10,50
340*FX12,0
350END
```

Program 2. Colours for model B

```
10*********************************
20
30REM "NEW YORK"
40REM MULTICOLOURED PATTERNS
50REM PETER VOKE  1982
60
70*********************************
80
90MODE 5:DIM J%(3)
100VDU23;8202;0;0;0;:*TV0,1
110
120FOR I%= 0 TO 3
130J%(I%)=RND(8)-1:K%=I%
140K%=K%-1:IF K%<0 GOTO 160
150IFJ%(I%)=J%(K%) GOTO130 ELSE GOTO140
160VDU19,I%,J%(I%);0;:NEXT
170
180CLS:T=10+RND(70):REPEAT:T=T-1
190HI%=512+RND(511):LO%=RND(511)
200RT%=640+RND(639):LT%=RND(639)
210GCOL3,RND(3)
220FOR Y%=LO% TO HI% STEP 8
230MOVE LT%,Y%:DRAW RT%,Y%:NEXT
240UNTIL T<0 OR INKEY(-69)
250
260IF INKEY(-69) GOTO 120
270*FX15,1
280PRINT TAB(1,30)"NEW COLOURS? (Y/N)"
290Y$=GET$:IF Y$="Y" OR Y$="y" GOTO120
300IF Y$<>"N" AND Y$<>"n" GOTO 270
310
320VDU20:MODE 7
330CLS:END
```

Program 3. Random pattern generator

```
 10*********************************
 20
 30REM "GCOL"
 40REM DEMONSTRATES THE EFFECT OF
 50REM VALUES OF GCOL 1ST PARAMETER
 60REM PETER VOKE  1982
 70
 80*********************************
 90
100MODE 7:B%=0:IF HIMEM>&6000 B%=-1
110IF B% THEN MODE 2:ELSE MODE 5
120PRINT TAB(0,31):VDU5
130@%=&0303:*FX9,0
140
150MOVE 0,900
160INPUT "INPUT A NUMBER LESS THAN 250: --"G%
170IF G%>255 THEN G%=G%-256:GOTO 170
180H%=0
190PRINT ''''''''''''"Press SHIFT for
   more"'''"or DELETE to stop."
200IF B% GOTO 230
210VDU19,3,3;0;19,0,4;0;19,2,2;0;
220
230REPEAT
240
250FOR C%=1 TO 9
260MOVE579,96:MOVE579,32
270FOR X%=1 TO 7:GCOL0,X%
280PLOT85,579+100*X%,96
290PLOT85,579+100*X%,32
300NEXT
310IF C%=9 THEN 400
320GCOL0,7:MOVE 0,80:PRINTG%,H%
330GCOLG%,H%
340MOVE 479,96:MOVE 479,32
350PLOT85,1279,96:PLOT85,1279,32
360VDU4,10,10,5
370H%=H%+1
380IFH%>7 THEN H%=0:G%=G%+1
390IF G%>255 G%=G%-256
400NEXT
410
420IF NOT(INKEY(-1) OR INKEY(-90)) GOTO 420
430UNTIL INKEY(-90)
440
450VDU4,20:MODE 7
460END
```

Program 4. More reliable than program 3

```
 10*********************************
 20
 30REM "STRIPES"
 40REM DEMONSTRATES COLOUR MIXING
 50REM BY USER CHARACTERS.
 60REM PETER VOKE  1982
 70
 80*********************************
 90
100MODE 2:MOVE 0,1023:VDU5
110VDU23,224,255,0,255,0,255,0,255,0
120VDU23,225,0,255,0,255,0,255,0,255
130A$=STRING$(18,CHR$(224))
140B$=STRING$(18,CHR$(225))
150
160FOR C1%=1 TO 7:FOR C2%=0 TO 7
170FOR T%=1 TO 4
180GCOL0,C1%:PRINT A$
190VDU11:GCOL0,C2%:PRINT TAB(2) B$
200VDU11:NEXT
210NEXT:A=GET:NEXT
220VDU4:END
```

Program 5. Displays all possible colour mixes (A and B)

random generator for model A, but uses colour mixtures.

A simple way of obtaining these shades reliably and predictably is to use program 4. The user definable characters 224 and 225 have been set up to fill in alternate lines, 224 filling in one set, 225 the other. Lines 110 and 120 set up the characters.

In this program model A owners should use MODE 5 in line 100. The VDU5 in line 100 is important as it allows the second character to be printed on top of the first without destroying it, and prevents scrolling. If VDU5 is left out, everything becomes faster, but only one character of the two can be printed in any position, mixing its colour with the background. Without the VDU5, use COLOUR 0 instead of GCOL 0,C. When speed is everything, user defined characters and no VDU5 is the way to do it.

Let us now look at byte-poking and related methods. If you have never seen it, try this in mode 5:

FOR X% = HIMEM + 1 TO HIMEM +10240: ?X%= 15: NEXT

The screen fills with red. Changing the 15 to 240, produces yellow. Now change 240 to 90. Orange results, made up of red and yellow stripes, but the stripes are vertical instead of horizontal.

To understand this, we have to know how the computer codes the colours in its memory. In modes 0, 3, 4 and 6 it is simple with only two logical colours, 0 and 1. The first byte of the so-called screen memory (beyond HIMEM) contains the information for the first eight pixels across the top of the screen in all cases, though the pixels are twice as wide in modes 4 and 6 as in mode 0 or 3. The next byte codes for the eight pixels *underneath* the first eight, and so on to the eighth byte, making an eight by eight matrix of pixels – the first character on the screen. The ninth byte codes for the eight pixels at the top of the next character along (figure 1). This continues all the way along the line, and onto the next, to the bottom of the screen.

But what has this to do with colour modes? Simply that the same sequence of bytes in memory is assigned to the same sequence of small strips on the screen (as in figure 1) in all modes. In modes 4

to 6 the strips are twice as wide as in modes 0 to 3, while modes 3 and 6 just put some space between lines. However, in a colour mode individual pixels within a strip are bigger.

For instance, in mode 5 the pixels are twice as wide as in mode 4, so there are only four in the strip instead of eight. There are still eight bits in the byte memory, so each pixel has two bits – just enough to code for four colours. The two bits for a pixel represent the colours in just the way you would expect: 00 for logical colour 0, 01 for logical colour 1, 10 for 2, and 11 for 3 (if you know your binary). The tricky part is the way these four pairs of bits are arranged in the byte. The bits for pixel 1 are in positions 1 and 5, those for pixel 2 are in positions 2 and 6, 3 in 3 and 7, 4 in 4 and 8. Figure 2 may make it clearer. Pixel 1 is at the right end of the strip, pixel 4 at the left.

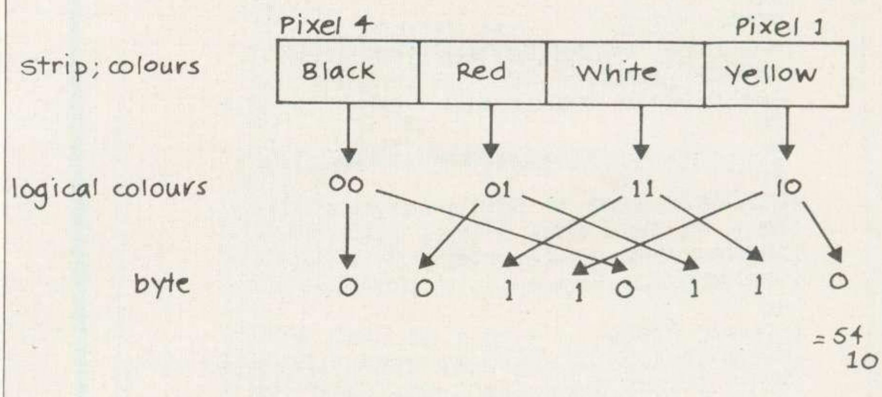


Figure 2. Bit pair arrangement in byte

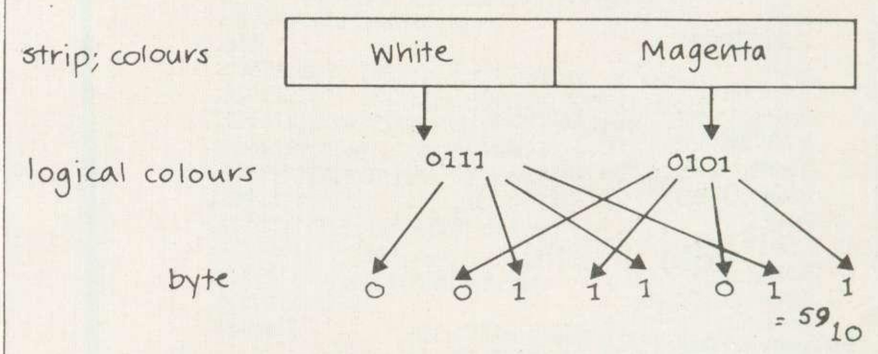


Figure 3. Merging in mode 2

The orange effect was produced by alternating red and yellow, colours 1 and 2, within the strip. Merging 1, 2, 1, 2 as in figure 1 gives 90. Another way would be to alternate 2, 1, 2, 1, which gives 165. A less stripey, more checkerboard effect can be obtained by putting 90 in the first byte, 165 in the second, 90 in the third, and so on.

Model B owners will find the above method works in mode 1, although the resolution is finer as the strips are half the width. In mode 2 things are a little different since each pixel has the possibility of being any one of 16 colours, and needs four bits to code it. There are only two pixels per strip, and the merging of binary numbers is shown in figure 3.

By now you may have noticed the diagonal stripes mentioned earlier moving across the mixed colours, rather like radio interference on a TV picture. This is due to drifting of the horizontal sync, causing the colours to wash across each other.

A faster method of producing these mixtures is provided by the Basic commands GCOL and PLOT. GCOL is followed by two numbers, G and H, the first of which specifies the 'action' and the second the logical number of the colour to be plotted. Making H bigger than the number of logical colours has no special effect; but making G bigger than 4, its normal maximum, produces mixed colours which are the same as the ones created by poking the screen memory directly – but does it much more quickly. In mode 2 the mixtures are usually flashing.

The parameter G can be given any value up to 255 before it starts to repeat its actions. Values 0 to 4 are the usual ones (*User Guide* page 262), while 5 to 255 produce mixtures. The effect not only depends on the values of G and H, but on the colour plotted on top, and the specific assignments of actual to logical colours made by VDU19 commands. The best way of making use of this method is to have a program on hand that shows all possible mixtures, and gives the numbers G and H needed to produce them, hence program 5.

The program works in mode 2 for model B, or mode 5 for model A. First the colours available in the mode are plotted in columns across the screen. Then the values of G and H are written on the left, GCOL G,H is called (line 330) and PLOT85 is used to plot a strip of mixture across the other colours. The 'underneath' colours show at the bottom of the screen. Since so many of the mixtures are flashing, this is turned off using *FX9,0 in line 130.

To get a particular mixture, note the pure colour at the bottom of the same column, and the figures G and H printed on the left. In the program where you want the mixture, first ensure the same pure colour is plotted in the area concerned, using GCOL0,N and PLOT. Then do GCOL G,H using the values of G and H given by program 5, and replot over the same area with PLOT85 or 81.

Model A owners should work in mode 5, and line 210 selects the palette. Change this line for a different set of colours, but always use the same palette in any program.

Ten minutes spent playing with program 5 will convince anyone the BBC micro has a cauldron of colour effects hidden inside.

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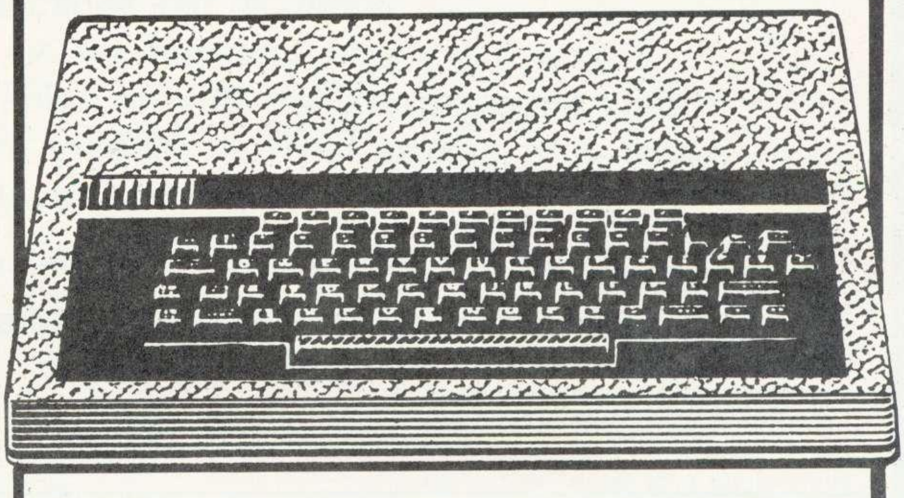
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A POT POURRI OF ROUTINES

Reader response has galvanised Beeb Guru Joe Telford into producing this month's wealth of ideas. Procedures, discs, functions and recursion are all dealt with in simple terms giving some elegant results

This month we look at a number of hints which cover some library routines and FX calls. First, though, a word of thanks to readers who have written in appreciation of my column. *Acorn User* readers are always willing to share their knowledge and expertise, so this month I include a number of their useful ideas. They are all expanded upon, so complaints to me please, *not* to our helpful readers.

Sergeant T M Murphy of Blandford Camp, Dorset, suggests that disc system users who wish to enter the cassette filing system on break need simply press delete-break. In fact holding down any key while tapping break will let you enter the CFS from DFS. However, that character is displayed after the break message, and because of auto repeat the character is soon multiplied. This happens with delete too, but because it is an invisible character and it cannot delete past the beginning of the line the screen display is left uncluttered. Pressing delete-shift-break produces the message:

```
BBC Computer
Searching
File not found
BASIC
>
```

I first assumed that the DFS was hunting for a program on disk, but on noticing no drive lights, I realised that this couldn't be the case. The speed of access between 'Searching ' and 'File not found' indicates that the micro is searching memory. As OS 1.0 onward have the *ROM command, I presume that the delete-shift-break combination is trying to autoboot a program in ROM. I have View and Wordwise in my machine and neither of these were run, so the *ROM filing system seems to deal with Basic applications programs. Who will produce the first applications chip?

Concluding, I notice that in all these cases page is not altered ie it remains at &1900 for disc based systems. Further information on the OS will be given in a future Hints and Tips.

page 30 ▶

RELOCATING PROGRAMS WITH DISCS

Regular readers will be aware of different techniques used by myself and that master of machine code, Ian (Buzz-bomb) Birnbaum, over the problem of relocating large programs. If you have a machine with a DFS chip then the memory from &E00 to &1900 is used by the DFS. Some programs will load into the space left, but not execute. The solution is to relocate them beginning at &E00 (&E00 is page for V 0.1 OS).

How we do this is the problem. In January, I suggested an approach in Basic using a user defined key. I felt this was simple and being in Basic (is there a better language?) easy to understand. Ian followed up with a high-powered machine code routine to go one better, and that was that. However, driven by a couple of letters from readers, I felt that the honour of Basic was at stake, and so I offer program 1.

This routine can be spooled then added to any existing program. Running the complete program on machines with page set at &E00 will result in no relocation. Page set to any other value, ie for DFS or Econet, will result in a jump to line 32000 where the CFS is selected and the Basic code moved down to &E00. Line 32015 resets top and the program is then re-run. This time, however, page is &E00 and so the program proper is executed. This routine takes about three or four seconds to relocate a program of 10k, which seems reasonable. It was produced by the Micro-electronics Education Programme when it was discovered that some of the programs commissioned for the Primer Pack were too large to fit into a BBC micro with a resident DFS chip. I am grateful to Bob Coates for permission to reproduce the coding.

```
    1 IF PAGE<>&E00 GOTO32000
    2 CLEAR:?&E04=244

32000 *TAPE
32005 FORI%=0 TO TOP-PAGE STEP4
32010 I%!&E00=I%!PAGE:NEXT
32015 ?&13=?&13-(PAGE-&E00)DIV 256
32020 PAGE=&E00:RUN
```

Program 1. Relocation

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Grundy Newbrain	●								
Texas T199 4A	●								
Atari 400/800 or Osborne 1	●								
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AU4

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```
10 X=0
20 PROC_recur
30 END
40 DEFPROC_recur
50 X=X+1
60 PRINTX
70 PROC_recur
80 ENDPROC
```

Program 2. Procedure recursion

```
10 X=0
20 PRINTFN_recur
30 END
40 DEFFN_recur
50 X=X+1
60 PRINTX
70 PRINTFN_recur
80 =X
```

Program 3. Function recursion

RECURSION, OR HOW TO GET A PROCEDURE TO CALL ITSELF

BACK to procedures and functions. Can a procedure or function call itself? The answer is 'yes' and the process is called recursion. It is useful to know how many times a function or procedure can call itself in a recursive loop.

Running program 2 shows how many times a procedure can call itself. The maximum number of times this can happen depends on how many procedures are in memory, each one reduces the number of times any particular procedure can call itself. Now add line 65:

65 IF X=1930 THEN ENDPROC

This stops the recursion when X is 1930 (almost the maximum number of times the procedure can call itself). There is a short delay when the condition of line 65 is true, because the program has to 'ENDPROC' down 1930 levels of recursion to conclude the procedure.

We can try the same technique with a defined function. Look at program 3 and run it to check on the number of times a function can call itself. As with procedures the maximum number of recursive calls depends on how many other functions coexist in the program. Adding line 65:

65 IF X=930 THEN =X

demonstrates visually the 'domino' effect of returning from the 930th recursive call.

Why use recursion? Well, let's consider the problem of finding the factorial of a number. Figure 1 shows the calculations required for factorials. How can this be coded in Basic for the BBC micro? The problem is that the sequence cannot easily be expressed as a formula and, therefore, the solution to the problem may be more easily found by a repetitive algorithm. Program 4 is one possible solution. This is probably acceptable to most users, though it requires variables and would need fitting into a procedure for regular use. Some would consider program 5 an improvement. It is about the same length as program 4 but includes the function, already defined. It should be easy to follow, as the only complicated line is line 50 which simply says:

> 'While the number you are at (n) is more than 0, multiply F by it, calling the answer F, and reduce the number by 1 then repeat this line with the new number you have reached.'

Perhaps not so simple? Anyway, the best way to become used to recursion is to do it again and again and . . .

Now that the number of disk users are increasing, we need to produce some library routines, which will run as self-contained units in any program. I now offer some possibilities to start libraries

```
10 F=1:n=5
20 FOR i= n TO 1 STEP-1
30 F=F*i
40 NEXT i
50 PRINT F
```

Program 4. Factorials from loops

```
10 F=1
20 PRINTFN_factorial(5)
30 END
40 DEFFN_factorial(n)
50 IF n>0 F=F*n:=FN_factorial(n-1)
60 =F
```

Program 5. Factorials from recursion

```
Factorial        Calculation                          Answer
    1      1                                            1
    2      2 * 1                                        2
    3      3 * 2 * 1                                    6
    4      4 * 3 * 2 * 1                               24
    5      5 * 4 * 3 * 2 *-1                          120
   ..      ..     ..     ..     ..                     ..
   ..      ..     ..     ..     ..                     ..
   ..      ..     ..     ..     ..                     ..
    n      n * n-1 * n-2 * n-3 ..... 1                ???
```

Figure 1. Factorial calculations

```
8300 DEFPROC_backing(x$)
8310 LOCAL J%
8320 CLS
8330 FOR J%= 0 TO 24
8340 PRINTTAB(0,J%);x$;CHR$157;
8350 NEXT
8360 VDU30
8370 ENDPROC
```

Program 6. Mode 7 background

```
8000 DEFPROC_dblht(x$,x,y)
8010 PRINTTAB(x-1,y);CHR$(141);x$
8020 PRINTTAB(x-1,y+1);CHR$(141);x$
8030 ENDPROC
```

Program 7. Double-height characters

```
8100 DEFPROC_delay(time)
8110 LOCAL z
8120 z=TIME+(time*100)
8130 REPEAT UNTIL TIME)z
8140 ENDPROC
```

Program 8. Delay procedure

```
8200 DEFPROC_space
8210 PRINTTAB(7,24);
8220 PRINT"Press SPACE to continue";
8230 *FX15,1
8240 REPEAT UNTIL GET=32
8250 ENDPROC
```

Program 9. Space bar move procedure

off. They need *SPOOLing to disc so that they can be EXECed at a later date.

If a routine is to provide a value needed in the main body of a program then that routine should be defined as a function. If the routine is doing something which doesn't need a value returned, then the routine may be defined as a procedure. Generally speaking, a function can do anything which a procedure can, though the reverse is not necessarily the case.

Look at program 6, which is a procedure intended to clear a mode 7 screen to a required background colour. The effect appears almost instantaneously, and is very effective.

The procedure is called by a line such as

PROC_backing(CHR$130)

The CHR$130 can be reduced to the key sequence (quotes SHIFT–f2 quotes> on machines with OS 1.00 or later. The shifted function keys and related colours are given in the *User Guide* on page 439. The basic idea of the routine is to print the colour character transmitted as a parameter (x$) down the left-hand side of the screen. This is followed by the teletext control character 157, which turns the background for that line to the colour preset by x$. Remember that if you print on any line after calling this procedure that the first two positions in each row must not be overwritten or the background for that line will vanish. Note also that any text will need to be preceeded by a colour character. For example, following the procedure call with

P."Hello Cheeky"

will destroy the background effect, while

P.TAB(2,0);"Hello Cheeky"

would be invisible. Success is

P.TAB(0,2);CHR$129"Hello Cheeky"

which shows up as red lettering, unless you have selected a red background. Note that this clumsy CHR$129 can be avoided by shifted function keys. For example, in

P.TAB(0,2);"rHello Cheeky"

where the first 'r' indicates a character formed by pressing SHIFT–f1.

Program 7 is a very simple procedure which prints double-height characters at any point on the mode 7 screen. The information is passed in three parameters:

- x$ – the string to print (which might be prefixed by a colour code);
- x – the column position of the start of the string;
- y – the row position of the string.

A possible calling line might be:

PROC_dblht("Hello Cheeky",14,12)

which would print a double-height message centrally on the screen.

Looking at the routine, the x–1's of lines 8010 and 8020 are there so that the x value transmitted is actually the start of the string. This is because the double-height on character, CHR$141, is issued just before the string. It is also possible to print double-height numbers by converting them to strings:

Number = 12 * 8
PROC_dblht(STR$(Number),10,2)

will print 96 in double-height numbers at TAB(10,2). One value of such simple procedures as that there is a saving on space within the program. If users need double-height lines more than three times in a program then the double-height routine can save memory. In a long program, such a simple routine could save hundreds of bytes.

Program 8 is another short routine which does nothing for a specified time. Calling the procedure:

PROC_delay(.5)

will cause the program to hesitate during its execution by a half second. Any time from 0.01 seconds to millions of seconds could be passed as a parameter, though at 0.01 seconds the procedure is inaccurate, because of the time taken in calling the routine. As the delay required increases, so the accuracy improves, and is acceptable for normal delays, say 0.25 seconds upwards.

Delays in a program are useful, but it is often better to let a program progress at the rate of its user, (this is particularly true with children using programs, as they need to think and re-read text).

Look at Program 9 which is called by the line:

PROC_space

and prints the message "Press SPACE to continue" in the centre of the bottom line of the mode 7 screen. The current buffer is flushed by line 8230 but

experiment with *FX15,0 or *FX21,0. Altering the program to run in any mode is simply a matter of changing the numbers 7 and 24 in line 8120 to centre text on the last line of the screen.

Remembering the comments about functions being used to return a value to the program, one useful library routine which could be coded as a function is the general purpose input routine (GPIR) of program 10. The MEP project maintains that a GPIR is a concept rather than a particular routine, and so the version presented is only one realisation. Users should provide their own versions.

Rather than explore this function line by line, I will describe how to use it, and what features are available.

Value	result
0	No effect
1	Convert to Upper Case
2	Convert to Lower Case
3	Capitalizes 1st letter of names

Figure 2. Results of 'effect' parameter

A possible calling line would be:

month=FN_gpi(2,2,"0123456789")

which says get a two-digit number from the digits available in quotes and place it into the variable 'month'.

The benefits of the routine are:

- It operates at any point on the screen (you *must* tab to the required position first).
- Only the number of characters set by the first parameter (len) are accepted, though it is possible to delete back through the string.
- Problems associated with the input command are automatically overcome.
- End of text entry field is signalled by sound, as are unacceptable characters.
- The range of valid characters can be set on entry to the routine.
- Special effects are featured to control input, using the effect parameter.

Let's examine each parameter in turn. First 'len'. This value tells the function how many characters are allowed in the text entry field. Each possible character is marked by a dot, over which characters may be typed. The dots re-appear on deleting. Any attempt to enter more than the number of characters set by len is ignored, though there is a short beep. Exit from the GPIR is only after pressing return.

The next parameter is 'effect'. This may be a value from 0 to 3 inclusive. It alters each character as it is typed at the keyboard using figure 2.

The last parameter is 'valid$', a

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```
10 ON ERROR GOTO 90
20 MODE4
30 REM MAIN PROGRAM
40 REPEAT
50 CLS
60 INPUT LINE"Procedure name: "Q$
70 UNTIL NOT EVAL ("FN_"+Q$)
80:
90 IF ERR <> 29 THEN MODE 7:
REPORT:PRINT" at ";ERL:END
100:
110 PRINT"Sorry, Procedure
";Q$;" doesn't exist"
120:
130 IF FN_ready THEN 30
140 END
150:
160 REM define Procs from here.
180 DEFFN_SQUARE
190 MOVE 200,200
200 DRAW 400,200
210 DRAW 400,400
220 DRAW 200,400
230 DRAW 200,200
240 =FN_ready
260 DEFFN_TRIANGLE
270 MOVE 200,200
280 DRAW 400,200
290 DRAW 300,300
300 DRAW 200,200
310 =FN_ready
330 DEFFN_OBLONG
340 MOVE 200,200
350 DRAW 800,200
360 DRAW 800,500
370 DRAW 200,500
380 DRAW 200,200
400 DEFFN_ready
410 PRINT"SPACE continues
 - any other exits"
420 =GET=32
```

Program 11. Elegant PROC calls

```
9000 DEFFN_gpi(len,effect,valid$)
9010 LOCALa$,b
9020 a$=""
9030 PRINTSTRING$(len,".");STRING$(len
+1,CHR$(8));" ";:*FX15,1
9040 b=GET:IF b=13 THEN =a$
9050 IF b=127 AND a$="" THEN 9040
9060 IF b=127 a$=LEFT$(a$,LEN(a$)-1):
PRINTCHR$b;".";CHR$(8);:GOTO9040
9070 IF effect=0 THEN9100
9080 IF effect=1 b=b AND 223 ELSE
b=bOR32
9090 IF effect=3 AND(RIGHT$(a$,1)=" "
OR a$="") b=b AND 223
9100 IF LEN(a$)=len OR
INSTR(valid$,CHR$b)=0 VDU7:GOTO9040
9110 PRINTCHR$b;:a$=a$+CHR$b:GOTO9040
```

Program 10. Possible GPIR



Published in April 1983

THE BEEB COMPOSES

Jim McGregor and Alan Watt explain how to compose any style of music using a BBC micro. Their programs analyse style and generate rhythm structures and pitch values from the results

Music has been called a compromise between chaos and monotony. Program 1 provides an example of chaos and program 2 three examples of well-organised monotony. For a computer to compose interesting music, there must be some degree of each involved, and it must satisfy certain rules that make it recognisable.

Random music is not necessarily unpleasant, particularly if the texture of the music is controlled. Program 3 illustrates this point and plays music selecting two random numbers to drive the pitch and duration in a sound statement. Superimposed on this basic method are three effects:

- an echo (two sound statements referencing separate envelopes);
- a glissando or slide (*de rigueur* in arcade games) at pseudo-random instants;
- pitch distortion at pseudo-random instants.

The net effect is not uninteresting. The pitch distortion is inserted by changing the parameters in a single envelope statement. In this case, we could have used two envelope statements with different parameters and selected, but the setting and resetting of envelope parameters (PROCpitchset and PROCpitchreset) is the structure required for dynamically changing envelope parameters and back again in a playing loop.

Rhythm is a very important component of all music. Indeed in some primitive cultures, music consists of rhythm and very little else. We examine ways of making a computer generate a rhythmic structure that is similar to that of a simple folk tune.

In music, rhythm is concerned with the grouping of notes into beats, of beats into bars, bars into phrases and so on. In the *Oxford Companion to Music*, the entry under 'phrase' states that any simple four line hymn or folk tune falls clearly into two halves or 'sentences'. Each sentence falls into two phrases and each phrase normally consists of four bars (although this is sometimes varied). We shall use this simple model for our first attempts at automatic composition.

To a computer scientist or linguist, the above description suggests the use of a 'generative grammar' to describe the structure of a piece of music. Such grammars are used extensively by computer scientists to describe the structure of programming languages. In this case we might start with the rule:

TUNE ::= SENTENCE SENTENCE

which we read as 'a tune consists

```
 10  ENVELOPE 1,1, 0,0,0,0,0,0,
              126,-4,0,-63,126,100
 20  ENVELOPE 2,1, 0,0,0,0,0,0,
              63,10,0,-63,63,110
 30  ENVELOPE 3,1, 0,0,0,0,0,0,
              126,-8,0,-10,126,50
 40  FOR note=1 TO RND(100)
 50    channel = RND(3)
 60    envelope = RND(3)
 70    pitch = RND(256)-1
 80    duration=RND(32)
 90    SOUND channel,envelope,pitch,duration
100  NEXT note
```

Program 1. Chaos

```
 10  ENVELOPE 1,1, 0,0,0,0,0,0,
              126,-4,0,-63,126,100
 20  ENVELOPE 2,1, 0,0,0,0,0,0,
              63,10,0,-63,63,110
 30  ENVELOPE 3,1, 0,0,0,0,0,0,
              126,-8,0,-10,126,50
 40  FOR note = 1 TO 20
 50    SOUND 1,1,53,8
 60  NEXT note
 70  key=GET
 80  FOR pitch=53 TO 101 STEP 4
 90    SOUND 1,1,pitch,8
100  NEXT pitch
110  key=GET
120  FOR phrase = 1 TO 10
130    SOUND 1,1,53,8
140    SOUND 1,1,69,8
150    SOUND 1,1,81,8
160    SOUND 1,1,101,8
170  NEXT phrase
```

Program 2. Monotony

```
 10  ENVELOPE 1,1, 0,0,0,0,0,0,
              126,-4,0,0,126,100
 20  ENVELOPE 2,1, 0,0,0,0,0,0,
              63,-4,0,0,63,50
 30  prevnote = 0
 40  FOR I = 1 TO 100
 50    note = RND(255)
 60    IF note MOD 11 = 0 THEN PROCslide(prevnote,note)
 70    IF note MOD 7 = 0 THEN PROCpitchset
 80    SOUND 1,1,note,RND(8)
 90    SOUND 1,2,note,RND(8)
100    prevnote = note
110    PROCpitchreset
120  NEXT
130  END

140  DEFPROCslide(old,new)
150    IF old>new THEN step = -1 ELSE step = 1
160    SOUND &1001,0,0,0
170    FOR i = old TO new STEP step
180      SOUND &1001,0,0,0
190      SOUND &11,1, i, 2
200      PROCpitchreset
210    NEXT
220  ENDPROC

230  DEFPROCpitchset
240    pi1 = 16:pi2 = -16: pi3 = 16
250    pn1 = 2: pn2 = 4:  pn3 = 2
260    ENVELOPE 1,1, pi1,pi2,pi3,pn1,pn2,pn3,
                126,-4,0,0,126,100
270  ENDPROC

280  DEF PROCpitchreset
290    ENVELOPE 1,1, 0,0,0,0,0,0,
                126,-4,0,0,126,100
300  ENDPROC
```

Program 3. Random stroll

```
   10 ENVELOPE 1,1, 0,0,0,0,0,0,
                 126,-8,0,-63,126,50
   20 ENVELOPE 2,1, 0,0,0,0,0,0,
                 100,-8,0,-80,100,50
  100 INPUT "Beats per bar",timesig
  110 INPUT "Minimum note",minnote
  120 PROCtune
  130 END

  200 DEF PROCtune
  210   PROCsentence
  220   PROCsentence
  230 ENDPROC

  240 DEF PROCsentence
  250   PROCphrase
  260   PROCphrase
  270 ENDPROC

  280 DEF PROCphrase
  290 LOCAL bar
  300   FOR bar=1 TO 3
  310     PROCbar(minnote)
  320   NEXT bar
  330   PROCbar(16)
  340 ENDPROC

  350 DEF PROCbar(minfinish)
  360   envelope = 1
  370   beatsleft=timesig
  380   REPEAT
  390     PROCselectgroup
  400     IF beatsleft=0 THEN PROCsubdividegroup(minfinish)
                         ELSE PROCsubdividegroup(minnote)
  410     FOR note=1 TO nextgroup DIV duration
  420       PROCplaynote
  430     NEXT note
  440   UNTIL beatsleft=0
  450 ENDPROC

  460 DEF PROCselectgroup
  470 LOCAL g,timeleft
  480   timeleft=beatsleft*8
  490   IF beatsleft=1 OR timeleft=minfinish THEN
          nextgroup=timeleft:beatsleft=0:ENDPROC
  500   REPEAT:g=RND(beatsleft)
  510   UNTIL beatsleft-g=0 OR timeleft-g*8>=minfinish
  520   nextgroup=g*8
  530   beatsleft=beatsleft-g
  540 ENDPROC

  550 DEF PROCsubdividegroup(mindur)
  560   IF nextgroup=mindur OR nextgroup MOD mindur<>0 THEN
          duration=nextgroup:ENDPROC
  570   REPEAT
  580     duration=2RND(5)
  590   UNTIL nextgroup MOD duration=0  AND duration>=mindur
  600 ENDPROC
  610 DEF PROCplaynote
  620   pitch=53
  630   SOUND 1,envelope,pitch,duration
  640   envelope=2
  650 ENDPROC
```

Program 4. Syntax generated hythm

of a sentence followed by another sentence'. We could then go on to define

SENTENCE ::= PHRASE PHRASE
PHRASE ::= BAR BAR BAR BAR

or we might decide that the last bar of a phrase should have a different structure from the other bars. Thus

PHRASE ::= BAR1 BAR1 BAR1 BAR2

where a BAR2 will have a different definition from a BAR1. Rules like these are usually referred to as 'rewrite rules'.

A more complicated example of a musical grammar might start off with

PIECE ::= SONATA I RONDO I FUGUE

The sign 'I' is read as 'or'. The rewrite rule states that a piece is either a sonata or a rondo or a fugue. The definition might continue with

SONATA ::= EXPOSITION DEVELOPMENT RECAPITULATION

Simple rewrite rules provide a concise notation for describing the structure of language or music, but they have many limitations and the system has to be 'augmented' for more advanced applications.

Returning to our simple folk-tune example, the structure of the rules constituting the grammar can be directly reflected in the structure of a Basic program that generates a piece of music from the grammar. In program 4, the rule defining a tune has been transcribed directly into a procedure that generates a tune.

```
DEF PROCtune
  PROCsentence
  PROCsentence
ENDPROC
```

Corresponds to rule

TUNE ::=SENTENCE SENTENCE

PROCsentence is defined similarly. These two procedures could have been combined into one, a tune being defined as four phrases, but it is always advisable to maintain a procedure structure that reflects the structuer of the process being modelled. We may decide later that the first sentence in a tune should have a slightly different structure than the second. Defining a tune in terms of sentences and a sentence in terms of phrases will make it easier to incorporate changes like this.

PROCphrase is defined in a similar way. It makes three identical calls of PROCbar and then a fourth call of PROCbar to generate the last bar of the phrase. The type of bar to be generated has been indicated by a parameter.

```
DEF PROCphrase
LOCAL bar
  FOR bar=1 TO 3
    PROCbar(minnote)
  NEXT bar
    PROCbar(16)
ENDPROC
```

Corresponds to rule

PHRASE ::= BAR1 BAR1 BAR1 BAR2

The parameter indicates the minimum duration permitted for the final note of the bar and we have created the last bar of a phrase (a BAR2) by supplying a different parameter, 16. This indicates that the bar generated by this call should have a final note of duration at least 16 time units, ie a minim. (A semibrieve has duration 32, a minim 16, a crotchet 8 and so on – see April's *Acorn User*). Forcing a phrase to end with a longish note gives an impression of rounding off the phrase. The first three bars of a phrase are allowed to terminate with the shortest permitted note available for the tune being composed. This value is called 'minnote' and is input to program 4 as a parameter. The value input determines the overall 'tempo' of the piece.

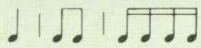
The 'grammar' of a bar will depend on the number of beats in a bar (another input parameter). For example, in 2/4 time, we could have

BAR1::=CROTCHETGROUP CROTCHETGROUP I MINIMGROUP

A bar can be a group of notes equivalent to a crotchet followed by another crotchet group, or a bar can consist of a group of notes

equivalent to a minim. We shall not allow note groupings to cut across the 'beat' structure of the bar. We could define

CROTCHETGROUP ::=



assuming a semiquaver as the minimum permitted note (duration = 2). *For convenience, we insist that notes in a group all have the same duration. We do not permit*

CROTCHETGROUP ::=



A minim group is defined as

MINIMGROUP ::=



Recall that we require a phrase to terminate with at least a minim. With two beats to the bar, this means

BAR2 ::= 

The complete grammar for 2/4 time is listed in figure 1. The whole process of generating a sequence of symbols (in this case notes of a certain duration) using rewrite rules can be viewed as a tree structure. Using choice where choice is available we could generate the tree shown in figure 1. This particular tree is just one of a large number that could be generated from the rewrite rules. BAR1 and BAR2 would be defined slightly differently if we had three or four (or more) beats to the bar. The definitions of BAR1 and BAR2 are implemented in a fairly *ad hoc* fashion in PROCbar in program 4.

The procedure repeatedly chooses a group consisting of a random number of whole notes less than or equal to the number of beats left to be played, subject to the constraint imposed by the 'minimum last note' parameter. Each group chosen is then split into an equal number of notes whose duration divides into the group chosen and whose duration is less than or equal to the minimum permitted duration. The notes of the group are then played (all on middle C).

One further enhancement that assists the listeners' perception of rhythm is to use a slightly louder envelope for the first note of a bar than that used for the remaining notes of the bar.

Listen to some of the output from program 4 and you will find that the 'sentence', phrase, bar and beat structure is usually fairly evident.

```
TUNE ::= SENTENCE SENTENCE
SENTENCE ::= PHRASE PHRASE
PHRASE ::= BAR1 BAR1 BAR1 BAR2
BAR1 ::= CROTCHETGROUP CROTCHETGROUP | MINIMGROUP
CROTCHETGROUP ::=
```



```
MINIMGROUP ::=
```



```
BAR2 ::=
```



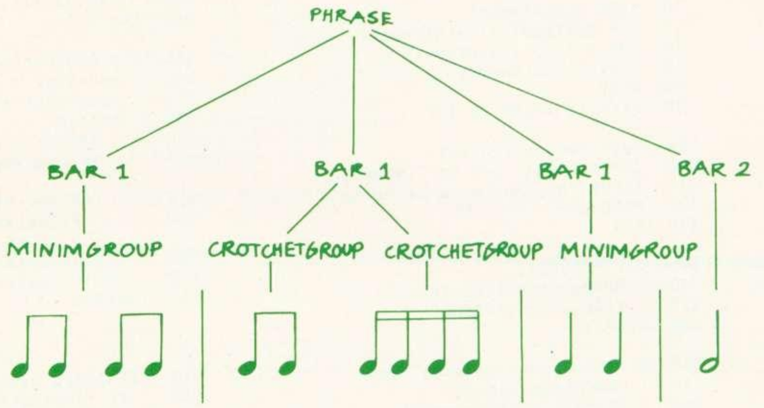


Figure 1. Grammar for 2/4 rhythm and part of sample once generated

major	53, 61, 69, 73, 81, 89, 97, 101
diminished	53, 57, 65, 69, 77, 81, 89, 93, 101
blues	53, 65, 73, 77, 81, 93, 101
Hindu	53, 61, 69, 73, 81, 85, 93, 101
whole tone	53, 61, 69, 77, 85, 93, 101
dorian minor	53, 61, 65, 73, 81, 89, 93, 101
aeolian minor	53, 61, 65, 73, 81, 85, 93, 101
harmonic minor	53, 61, 65, 73, 81, 85, 97, 101
pentatonic	53, 61, 69, 81, 89, 101
major arpeggio	53, 69, 81, 101

Table 1. Scales with sample pitch codes

We now turn our attention to the pitch of the notes played in the tune.

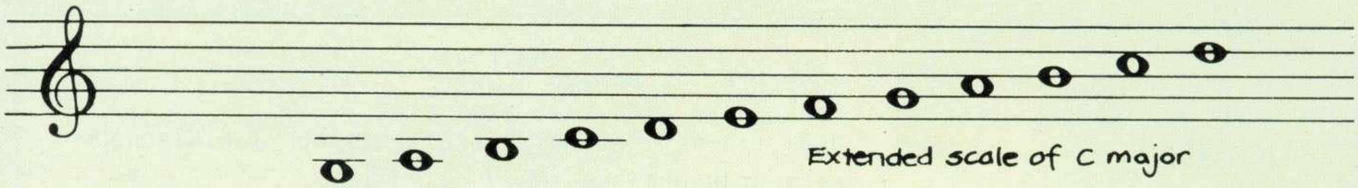
A particular piece of music (or at least a section of a piece of music) is usually confined to notes taken from a set of notes that are closely related to each other in some way. The set of notes, or 'scale', used contributes in a large way to the character of the music. Table 1 gives some scales and arpeggios together with sample sequences of pitch codes based on middle C. We can easily alter our rhythm on middle C program so that it selects random notes from a particular scale. Program 5 indicates the modifications needed to do this. The data statement at line 80 defines the number of notes and the pitch values for the scale used, in this case a major arpeggio.

One further addition has been made to this program. A new parameter is passed to each of PROCsentence, PROCphrase and PROCbar to indicate whether it is the final example of that construction in the tune. This enables the program to recognise the last note and constrain it to fall on the keynote of the scale.

Try running the program with notes taken from the major arpeggio and you will obtain a moderately pleasing if rather monotonous effect. Then try some of the other scales listed above.

We shall now use notes taken from the scale of C major extended downwards by three notes to lower G and up one note to upper D.

Once the set of notes (the key) on which a tune will be played has



Extended scale of C major

```
  10 ENVELOPE 1,1, 0,0,0,0,0,0,
              126,-4,0,-63,126,100
  20 ENVELOPE 2,1, 0,0,0,0,0,0,
              100,-4,0,-80,100,80

  30 READ scalelength
  40 DIM scalenote(scalelength)
  50 FOR n=1 TO scalelength
  60   READ scalenote(n)
  70 NEXT
  80 DATA 4, 52,69,81,101

  90 keynote=scalenote(1)
 100 INPUT "Beats per bar",timesig
 110 INPUT "Minimum note",minnote
 120 PROCtune
 130 END

 200 DEF PROCtune
 210   PROCsentence(FALSE)
 220   PROCsentence(TRUE)
 230 ENDPROC

 240 DEF PROCsentence(finalsent)
 250   PROCphrase(FALSE)
 260   PROCphrase(finalsent)
 270 ENDPROC

 280 DEF PROCphrase(finalph)
 290 LOCAL bar
 300   FOR bar=1 TO 3
 310     PROCbar(minnote,FALSE)
 320   NEXT bar
 330   PROCbar(16,finalph)
 340 ENDPROC

 350 DEF PROCbar(minfinish,finalbar)
 360   envelope = 1
 370   beatsleft=timesig
 380   REPEAT
 390     PROCselectgroup
 400     IF beatsleft=0 THEN PROCsubdividegroup(minfinish)
                         ELSE PROCsubdividegroup(minnote)
 410     FOR note=1 TO nextgroup DIV duration
 420       PROCplaynote(note=nextgroup DIV duration AND
                         beatsleft=0 AND finalbar)
 430     NEXT note
 440   UNTIL beatsleft=0
 450 ENDPROC
       .
       .
       .
 610 DEF PROCplaynote(finalnote)
 620   IF finalnote THEN pitch=keynote
       ELSE pitch=scalenote(RND(scalelength))
 630   SOUND 1,envelope,pitch,duration
 640   envelope=2
 650 ENDPROC
```

Program 5. Rhythm with random notes from a scale

been determined, there are a number of further constraints that can be applied to make a tune mimic a particular style as certain notes and combinations of notes will be more common than others.

One way of making our program select pitch values more systematically is to make it use probability distributions when selecting the pitch of a note to be played. The simplest (and least satisfactory) type of distribution that can be used is the first order probability distribution.

Table 2 shows the result of a 'first order analysis' of nine simple well-known tunes taken from a child's recorder tutor *(Baa Black Sheep, Bobby Shaftoe,* etc). If we imagine all these tunes being played in C major, on the 12 notes from lower G to upper D, then the figures in table 2 give, as percentages, the relative frequency of occurrence of each note over the nine tunes analysed. (These were produced by program 9.)

We now generate a note so that the probability of getting a particular note matches its entry in table 2. The tunes generated by doing this will not be much better than those obtained by choosing a random note from the scale, but the basic technique used is easily extended.

First set up an array containing the percentages in table 2. In order to select a note, we generate a random number in the range 0 to 100 and add up values from the array until the total exceeds the random number generated (see figure 2). The number of percentages added determines the note from the scale that is selected. This approach is implemented in program 6.

Note sequences are much more important in composing melodies, and if we want to constrain the note sequences that are chosen by our program, then consider higher order probabilities.

The use of second order probability distributions makes the choice of a note dependent on the preceding note.

Table 3 shows second order distributions resulting from analysis of our nine simple tunes. One row in this table corresponds to one of our notes and the entries in a row give the percentage of occasions on which each of the other notes followed the note to which the row corresponds. For example, row one indicates that lower G is followed

g	a	b	c	d	E	F	G	A	B	C	D
3.4	0.7	3.4	15.0	12.6	13.8	8.5	14.3	8.0	11.1	6.3	2.9

Table 2. First order note probabilities

	g	a	b	c	d	E	F	G	A	B	C	D.
g	42.9	0.0	0.0	28.6	14.3	7.1	0.0	7.1	0.0	0.0	0.0	0.0
a	0.0	0.0	66.7	0.0	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
b	21.4	0.0	7.1	50.0	21.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
c	0.0	0.0	12.7	40.0	14.5	18.2	10.9	3.6	0.0	0.0	0.0	0.0
d	7.7	0.0	7.7	26.9	28.8	13.5	9.6	5.8	0.0	0.0	0.0	0.0
E	0.0	3.5	0.0	17.5	26.3	21.1	14.0	17.5	0.0	0.0	0.0	0.0
F	0.0	2.9	0.0	0.0	20.0	45.7	8.6	22.9	0.0	0.0	0.0	0.0
G	0.0	0.0	0.0	3.5	1.8	15.8	21.1	22.8	31.6	0.0	1.8	1.8
A	0.0	0.0	0.0	0.0	0.0	0.0	3.0	24.2	18.2	48.5	0.0	6.1
B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.0	13.0	43.5	23.9	6.5
C	0.0	0.0	0.0	0.0	0.0	3.8	0.0	3.8	3.8	30.8	42.3	15.4
D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	16.7	8.3	25.0	16.7

Table 3. Second order probabilities

```
10  ENVELOPE 1,1, 0,0,0,0,0,0,
             126,-4,0,-63,126,100
20  ENVELOPE 2,1, 0,0,0,0,0,0,
             100,-4,0,-80,100,80

30  READ scalelength
40  DIM scalenote(scalelength)
50  FOR n=1 TO scalelength
60    READ scalenote(n)
70  NEXT
80  DATA 12, 33,41,49,53,61,69,73,81,89,97,101,109
90  keynote=scalenote(4)

100 PROCsetupfreqtable1
110 INPUT "Beats per bar",timesig
120 INPUT "Minimum note",minnote
130 notesplayed=0
140 PROCtune
150 END
    .
    .
    .
610 DEF PROCplaynote(finalnote)
620   IF finalnote THEN pitch=keynote
                   ELSE PROCselectpitch1
630     SOUND 1,envelope,pitch,duration
640     notesplayed=notesplayed+1
650     envelope=2
660 ENDPROC

670 DEF PROCsetupfreqtable1
680 LOCAL lb1,l,n,fileno
690   DIM freq1(12)
700   FOR n=1 TO 12
710     READ freq1(n)
720   NEXT n
730 ENDPROC

740 DEF PROCselectpitch1
750 LOCAL rand, n, sum
760   rand=RND(1)*100
770   n=0 : sum=0
780   REPEAT
790     n=n+1:sum=sum+freq1(n)
800   UNTIL sum>=rand
810   pitch=scalenote(n)
820   lastnoteplayed=n
830 ENDPROC

10010 DATA 3.4,0.7,3.4,15.0,12.6,13.8,8.5,14.3,8.0,11.1,6.3,2.9
```

Program 6. First order tunes

by another lower G on 42.9 per cent of occasions by middle C on 28.6 per cent of occasions by D next to middle C on 14.3 per cent of occasions, by E on 7.1 per cent of occasions and by upper G on 7.1 per cent of occasions.

The modifications to the previous program needed to generate notes according to the second order probability distributions are presented in program 7. The first note of the tune is generated using the previous one, and from then on, a note is generated according to the probabilities in the row of table 3 that corresponds to the previous note played. Using this method eliminates the occasional violent leaps in pitch that occurred with the previous version of the program. The entries in table 3 associated with such violent leaps are mostly 0.

The use of second order probability thus encourages the program to use commonly acceptable pitch intervals between consecutive notes.

If we want the program to use commonly-used sequences of notes, we can move on to third order distributions where the probability of choosing a note will depend on the two previous notes played. This makes a marked improvement to the sequences generated. We leave you to think about the details.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
freq 1	3.4	0.7	3.4	15.0	12.6	13.8	8.5	14.3	8.0	11.1	6.3	2.9

rand=RND(1)*100 Say, for example, rand=43.5. Then the first six values in freq1 added before we obtain a total that exceeds 43.5. This means that we play the sixth note in the scale.

pitch=scalenote(6)

Figure 2. Selecting a note by probability distribution

In case you want to analyse your own favourite type of music, we present program 8 which was used to generate the distributions of tables 2 and 3 together with the data for one tune (*Baa Baa Black Sheep*). The string at the start of the data for a tune establishes the range of notes for the tune starting three notes below the keynote. There then follow the names of the notes in the tune in the order in which they appear. The program prints the tables in the form of data statements numbered from 10000 upwards that can be absorbed into another program. To do this, type

```
*SPOOL "freqtables"
RUN
*SPOOL
```

and the data statements for the tables will be stored on cassette. These can be added to any program by typing *EXEC "freqtables".

If you want to analyse music that includes accidentals, then you will have to invent your own nomenclature for the notes involved and extend the program accordingly. You can make music more like the original by using higher probability orders, but as it becomes more like the target style it becomes less original.

Finally we return to letting the computer do its own thing and get it to play some 12 bar blues. Program 9 plays or improvises on 12 bar blues. It does not use probability tables but selects notes from two jazz blues scales (Bb and Eb, data statement 670). It uses a rhythmic chordal accompaniment and the three voices are synchronised using the technique in April's *Acorn User*, where we described how PROCinitialise, PROCharmonise and PROCsound work. Voices two and three are loaded up into rows two and three of the three row pitch and duration arrays, and a simple blues chord progression is taken from data statements 560 to 590. PROCjazz initialises row one of this array by randomly selecting starting notes for a phrase from the appropriate scale. The rhythm for a phrase is randomly selected from data statements (1091 onwards).

The creative part of the program could be significantly improved:

- The intervals used in the phrases are all major or minor seconds and could be varied.
- Rests or gaps of silence should be introduced as space is very important in music.
- Fast note phrases used consecutively should b e followed by a long note.
- Repetition of a phrase should be occasionally introduced.

▶

```
100  PROCsetupfreqtable1
101  PROCsetupfreqtable2
      .
      .
      .
610  DEF PROCplaynote(finalnote)
620    IF finalnote THEN pitch=keynote
       ELSE IF notesplayed=0 THEN PROCselectpitch1
                             ELSE PROCselectpitch2
      .
      .
      .
840  DEF PROCsetupfreqtable2
850  LOCAL l,n
860    DIM freq2(12,12)
870    FOR l=1 TO 12
880      FOR n=1 TO 12
890        READ freq2(l,n)
900    NEXT:NEXT
910  ENDPROC

920  DEF PROCselectpitch2
930  LOCAL rand, n, sum
940    rand=RND(1)*100
950    n=0 : sum=0
960    REPEAT
970      n=n+1 : sum=sum+freq2(lastnoteplayed,n)
980    UNTIL sum>=rand
990    pitch=scalenote(n)
1000   lastbut1=lastnoteplayed : lastnoteplayed=n
1010 ENDPROC

10010 DATA 3.4,0.7,3.4,15.0,12.6,13.8,8.5,14.3,8.0,11.1,6.3,2.9
20010 DATA 42.9,0.0,0.0,28.6,14.3,7.1,0.0,7.1,0.0,0.0,0.0,0.0
20020 DATA 0.0,0.0,66.7,0.0,33.3,0.0,0.0,0.0,0.0,0.0,0.0,0.0
           ... (Table 2)
```

Program 7. First order tunes

```
10  DIM freq1(12), freq2(12,12), freq3(12,12,12)
20  INPUT "Number of tunes",nooftunes
30  FOR tune=1 TO nooftunes
40    PROCanalysetune
50  NEXT tune

60  PROCstandardisetable1
70  PROCstandardisetable2

90  PROCoutputtable1
100 PROCoutputtable2

120 END

130 DEF PROCanalysetune
140 LOCAL scale$,lastbut1$,last$,next$,lastbut1,last,next
150   READ scale$
160   READ lastbut1$,last$,next$
170   lastbut1=INSTR(scale$,lastbut1$)
180   last=INSTR(scale$,last$)
190   freq1(lastbut1)=freq1(lastbut1)+1
200   freq1(last)=freq1(last)+1
210   freq2(lastbut1,last)=freq2(lastbut1,last)+1
220   REPEAT
230     next=INSTR(scale$,next$)
240     IF next=0 THEN PRINT "Error in DATA ";tune;" ";scale$;" ";next$
250     freq1(next)=freq1(next)+1
260     freq2(last,next)=freq2(last,next)+1
270     freq3(lastbut1,last,next)=freq3(lastbut1,last,next)+1
280     lastbut1=last:last=next
290     READ next$
300   UNTIL next$="Z"
310 ENDPROC

330 DEF PROCstandardisetable1
340 LOCAL n,total
350   total=0
360   FOR n=1 TO 12
370     total=total+freq1(n)
380   NEXT n
390   FOR n=1 TO 12
400     freq1(n)=freq1(n)*100/total
410   NEXT n
420 ENDPROC

440 DEF PROCstandardisetable2
450 LOCAL l,n
460   FOR l=1 TO 12
470     total=0
480     FOR n=1 TO 12
490       total=total+freq2(l,n)
500     NEXT n
510     IF total>0 THEN
          FOR n=1 TO 12:freq2(l,n)=freq2(l,n)*100/total:
          NEXT n
520   NEXT l
530 ENDPROC

660 DEF PROCoutputtable1
670 LOCAL n
680   PRINT "10000 DATA ";
690   @%=&20105
700   FOR n=1 TO 12
710     PRINT ;freq1(n); :IF n<12 THEN PRINT ",";
720   NEXT n
730   PRINT
740 ENDPROC

750 DEF PROCoutputtable2
760 LOCAL l,n,lineno
770   lineno=20010
780   FOR l=1 TO 12
790     @%=5
800     PRINT lineno;" DATA ";
810     @%=&20105
820     FOR n=1 TO 12
830       PRINT ;freq2(l,n); :IF n<12 THEN PRINT ",";
840     NEXT n
850     PRINT
860     lineno=lineno+10
870   NEXT l
880 ENDPROC

1120 DATA gabcdEFGABC, c,c,G,G,A,B,C,A,G,F,F,E,E,d,d,c,G,G,G,
                       F,F,F,E,E,E,d,G,G,G,F,G,A,F,E,d,d,c,Z
        ... etc. for other tunes.
```

Program 8. Generates first and third order frequency tables

```
10  ENVELOPE 1,1,0,0,0,0,0,0,63,10,0,-63,63,126
20  ENVELOPE 2,1,0,0,0,0,0,0,126,-4,0,-100,126,100
30  ENVELOPE 2,1,0,0,0,0,0,0,126,-4,0,-100,126,100
40  DIM pitch(3,200),duration(3,200),noofnotes(3),nextnote(3),clock(3)
50  tempo = 1
60  PROCinitialise(2)
70  PROCinitialise(3)
80  PROCjazz
90  PROCharmonise(3)
100 END

110 DEF PROCinitialise(voice)
****  Defined last month  ****
300 ENDPROC

310 DEF PROCharmonise(noofvoices)
***  Defined last month  ***
460 ENDPROC

470 DEF PROCsound(voice,sync)
***  Defined last month ***
550 ENDPROC

560 DATA 24, A#,h,A#,dq,A#,e,R,w,A#,e,A#,e,R,q,A#,dq,A#,e,R,w
570 DATA C'#,h,C'#,dq,C'#,e,R,w,A#,h,A#,dq,A#,e,R,w,D'#,w,C'#,w,
         A#,h,A#,dq,A#,e,A#,w
580 DATA 24, D',h,D',dq,D',e,R,w,D',e,D',e,R,q,D',dq,D',e,R,w
590 DATA G,h,G,dq,G,e,R,w,D',h,D',dq,D',e,R,w,R,w,R,w,D',h,D',dq,
         D',e,D',w

600 DEF PROCjazz
620   DIM Bb(13), Eb(13)
630   ii = 0
640   FOR note=1 TO 13
650     READ Bb(note)
660   NEXT note
670   DATA 45,57,65,69,73,85,93,105,113,117,121,133,141
680   FOR note = 1 TO 13
690     Eb(note) = Bb(note) + 20
700   NEXT note
710   PROCplaytheblues
715   noofnotes(1)=ii
720 ENDPROC

730 DEF PROCplaytheblues
740   PROCplaybars(4,"Bb")
745   PROCplaybars(2,"Eb")
750   PROCplaybars(6,"Bb")
760 ENDPROC

770 DEF PROCplaybars(n, key$)
780   FOR bar = 1 TO n
790     FOR phrase = 1 TO 2
800       PROCselectstartnote
810       PROCselectupdown
820       PROCselectphrase
830       PROCplayphrase(key$)
840     NEXT phrase
850   NEXT bar
860 ENDPROC

870 DEF PROCselectstartnote
880   startnote = RND(13)
890 ENDPROC

900 DEF PROCselectphrase
910   sphrase=RND(6)
920   restoreto = 1090 +sphrase
930   RESTORE restoreto
940 ENDPROC

950 DEF PROCplayphrase(key$)
960   READ noofnotes
970   note = startnote
980   FOR i = 1 TO noofnotes
990     READ length
1000    ii = ii + 1: duration(1,ii) = length
1010    IF key$ = "Eb"  THEN pitch(1,ii) = Eb(note)
                        ELSE pitch(1,ii) = Bb(note)
1020    note=note+ updown
1030    IFnote > 13 OR note < 1 THEN note=7
1040  NEXT i
1050 ENDPROC

1060 DEF PROCselectupdown
1070   IF RND(2) = 2 THEN updown= -1
                     ELSE updown=  1
1080 ENDPROC

1091 DATA 8,2,2,2,2,2,2,2,2
1092 DATA 4,4,4,4,4
1093 DATA 2,8,8
1094 DATA 1,16
1095 DATA 4,2,6,2,6
1096 DATA 11,1,2,1,2,1,2,1,2,1,2,1
```

Program 9. Micro Blues

IAN BIRNBAUM sets out to improve your programming techniques on the BBC micro.

He will answer reader's questions in this column and develop their ideas – as well as giving some of his own. But the real aim is for readers to provide the questions and the answers.

At least £5 will be paid for any tip published, with £10 for those which merit a one-star award and £20 for real humdingers!

The idea must be original and be described clearly and fully. It should not have been published before.

Your contribution should be typed or printed, with any substantial listings on cassette, but only included to make a point.

Send your hints or questions to BBC Forum, Acorn User, 53 Bedford Square, London WC1B 3DZ. Please include a self-addressed envelope if your contribution is to be returned. We cannot answer letters individually, but a cross-section of common and interesting points will be covered.

BUG STUMPS CASSETTE

Paul Knight writes from Devon: In the time I have owned a BBC model B, writing programs and recording them on cassette has produced no difficulties. However, having developed one particular program over 100 hours, I fear it is lost.

Having loaded the program from cassette, and made some amendments I tried to save the new program over the top of the old – a mistake I shall not repeat. The new program, longer than the previous, appeared to save correctly and as a check the tape was rewound. *CAT indicated all was well, and the numbers following the file-name were 29 2973.

When it next came to load the program, everything seemed to go well, but although the block numbers 29 2973 appeared, the tape was not turned off. The noise from the earpiece during loading sounds normal, but LIST produces nothing after Escape. Other frantic attempts yield at best 'bad program'.

There is clearly data on tape but I cannot extract it. This must be a common beginner's problem. Can you help?

From the description, I suspect the program is not loading at all! Let me explain.

When you load a program from tape, the operating system will search for block zero of the file with the appropriate name. Thus, if the program is called PROG, you should get on the screen:

Searching
Loading
PROG 00 etc

and the program will load.

However, if block zero is missing, you will get:

Searching
PROG 01 etc

and the program will not load! The clue is the omission of the word 'loading' (as well as there being no block 00).

This is a common problem

```
*OPT2,0
>*OPT1,1
>CLOSE#0:X=OPENIN(""):REP.:U.BGET#1=13:?PAGE=13:I%=0:REP.:I%=I%+1:I%?PAGE=BGET#1
:U.EOF#(1):CLOSE#1:*OPT2,1
```

Listing 1.

```
 10FORI%=0 TO 3 STEP3
 20P%=&C00
 30[OPTI%
 40LDA &1D
 50STA &71
 60LDA #0        \START ADDRESS IS PAGE
 70STA &70
 80TAY
 90
100LDA #&0D
110STA (&70),Y \CARRIAGE RETURN AT THE BEGINNING
120
130.LOOP1
140JSR INCRE
150LDY #0
160LDA (&70),Y
170CMP #&FF     \END IF = &FF
180BNE N
190RTS
200
210.N
220LDA &70
230STA &72      \START ADDRESS OF LINE
240LDA &71      \IS SAVED
250STA &73
260JSR INCRE
270JSR INCRE
280LDA #3       \INITIALISE COUNTER
290STA &74
300
310.LOOP2
320JSR INCRE
330INC &74      \INCREMENT COUNTER
340LDA (&70),Y
350CMP #&0D
360BEQ N2
370CMP #&20
380BCS LOOP2
390LDA #&40     \PUT @ IN PLACE OF CONTROL CHARACTERS
400STA (&70),Y
410JMP LOOP2
420
430.N2
440LDA &74
450LDY #2
460CMP (&72),Y \IS THE LINE SUM CORRECT?
470BEQ LOOP1    \YES....
480STA (&72),Y \NO,SO REPLACE BY CORRECT SUM
490BNE LOOP1
500
510.INCRE       \ROUTINE TO INCREMENT ADDRESS
520CLC
530LDA &70
540ADC #1
550STA &70
560LDA &71
570ADC #0
580STA &71
590RTS
600]NEXT
```

Listing 2.

LOADING

with OS 0.1, where occasionally block zero is not correctly recorded (April and September's **Acorn User** contain a fix to prevent this bug). *CAT will not pick this up, and is not the best way to verify. *LOAD ""8000 is better – and it gives an almost complete check whilst leaving your program intact.

This is all very well, but what about Mr Knight's program? Fortunately, there is a way to recover most of it. The key is to treat the program as a file, and read it byte by byte.

Type in listing 1 below, wind your tape to the program start and press PLAY. Most of it will load in. Ignore any 'Block?' errors (*OPT2,0 ensures the computer will ignore them).

Once loaded, the program should list, with just the last few lines missing. If by chance you get 'Bad program' use Mr Denis's machine code routine on it, and you should recover most of what you want.

Way round the dreaded bad program

£10

LISTING 2 gives a machine code routine from ***Mr E Denis of Brussells*** to retrieve any program when the dreaded 'Bad program' occurs. Save the assembly code as backup, and also save the machine code by running the listing and using *SAVE "BADPMC" 0C00 0CFF. Now *RUN "BADPMC" will retrieve your masterpiece lost in memory.

It will retrieve as much as possible, replacing any errant control codes by @. It is fairly straightforward to go through and locate the whereabouts of one of these. Alternatively, a short program could be written to do the search for you.

M. Cozens of Kent earns £5 for this tip on loading machine code and saving memory

£5

THE January *Acorn User* (page 25) indicated ways of reducing program length and loading machine code routines. The following is an alternative which has been used successfully. The machine code program to be located in say &C00 to &CFF is first loaded and run in OPT3, the contents of &C00 being noted, eg if the first code instruction is LDY #0 then &C00 would contain 160. The Basic program is then loaded and line numbering adjusted to allow a new first line of:

IF ?C00<>160THEN*LOAD "MC"

The Basic program is then resaved once on a clean tape, followed by the machine code saved as:

*SAVE "MC" C00 CFF

To use the program in future CHAIN"" the Basic program. This will automatically test the memory and if the machine code is not present LOAD it and then carry on. If the code is present, for example after an escape during program use, then the *LOAD command is ignored. In addition the original machine code program can contain key and character definitions, to be used later in the Basic program. These would be stored in &B00 onwards, of course.

TWO WARNINGS ON VDU DRIVERS

A number of letters have pointed out that VDU22 will change mode inside a procedure, but it is not quite as simple as that.

For example, listing 3 will work only when the value of HIMEM for mode B% is at least as high as for mode A%. That is, the following applies:

if A%=7, B% must be 7
if A%=6, B% must be 6 or 7
if A%=4 or 5, B% must be at least 4
if A%=3, B% must be at least 3
if A%=0, 1 or 2, B% can be anything

This said, it seems that in most instances you can just as easily change mode outside the procedure, and you should do so unless there is a good reason to execute the change inside.

☐Here's a warning about VDU14. Compare

FOR I%=1 TO 100:VDU14:PRINT I%:NEXT

with

VDU14:FOR I%=1 TO 100:PRINT I%:NEXT

Running them will produce different results. This is because each VDU14 resets the count for paging and so repeated use has no effect.

CLEAR RESETS LOMEM

One more point about CLEAR which does not seem to be widely known (see last month's column)

Like RUN, it resets LOMEM to the value of TOP. This is actually quite logical, and is used to good effect in my self-erasure routine (January's *Acorn User*).

```
10MODE A%:A$="Out of Procedure"
20PROCTEST("Inside Procedure"):PRINTA$:END
30DEF PROCTEST(A$):VDU22,B%:PRINTA$:ENDPROC
```

Listing 3.

A two-minute operation turns your BBC Micro into the heart of a word processor.

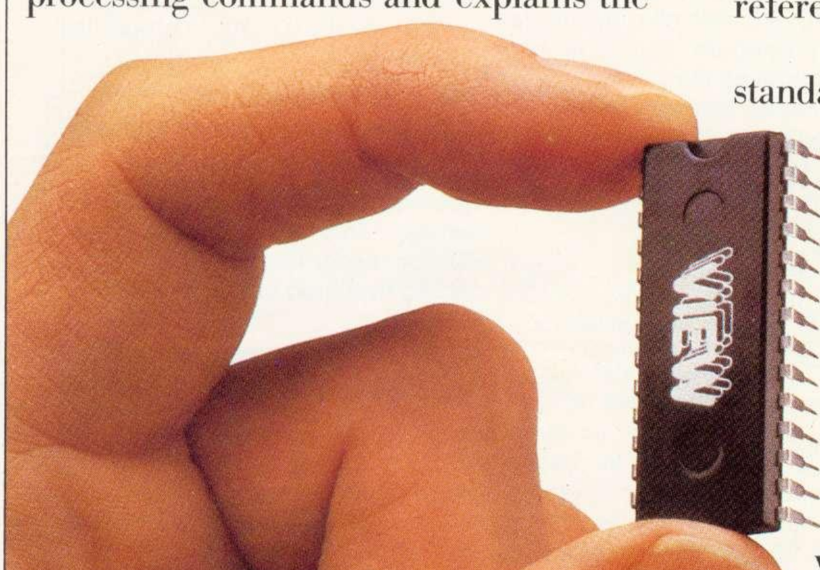
VIEW is a software program from Acornsoft (the software division of Acorn Computers Ltd., who designed and built the BBC Micro) that enables you to use your BBC Micro, together with a printer, as a fully operational word processor.

View is supplied as a Rom chip that can easily be fitted to your BBC Micro by your local dealer, in a painless two-minute operation.

Then, once installed, you only have to switch on and View is operating immediately. (You can easily switch back to normal computing with a single command.)



Also included in the View package are two special books: 'Into View,' that takes you by easy stages through all the word processing commands and explains the many ways in which View can help you, and the 'View Guide,' which provides a quick reference to all View facilities.



You'll find that View is, by any standards, a thoroughly professional system, yet still surprisingly simple for the beginner to master.

The 'Spark-Jet Printer' shown in the photograph is the ideal choice of printer for your word processing application. Extremely quiet, it offers high resolution graphics from monitor or T.V. screen and is available now from dealers.

If you'd like more information, write to Acornsoft, 4a Market Hill, Cambridge CB2 3NJ.

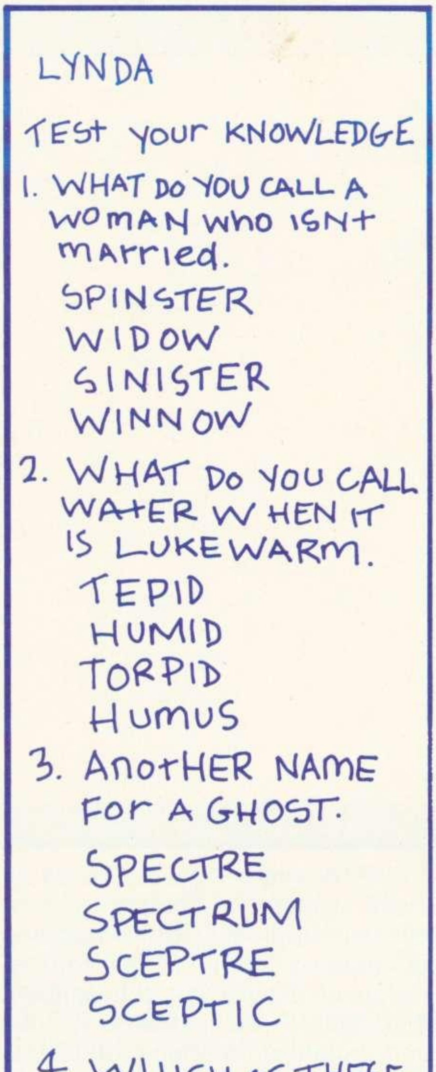
Or, for details of your local Acornsoft dealer, phone 01-200 0200.

ACORNSOFT

8 PAGE PULL-OUT

PRIMARY LANGUAGE DEVELOPMENT

Heather Govier outlines some exciting work on language programs for primary schoolchildren in the fifth part of our education series



LYNDA

TEST your KNOWLEDGE

1. WHAT DO YOU CALL A WOMAN who ISN'T married.
SPINSTER
WIDOW
SINISTER
WINNOW

2. WHAT DO YOU CALL WATER WHEN IT IS LUKEWARM.
TEPID
HUMID
TORPID
HUMUS

3. AnotHER NAME For A GHOST.
SPECTRE
SPECTRUM
SCEPTRE
SCEPTIC

4. WHICH OF THESE CAN YOU DRINK From.
GOBLET
GOBLIN
GLOBULE
GLOBULIN

5. WHICH IS A PART OF THE BODY
ARTERY
ARCHERY
ARTILLERY
ARTISTRY

Figure 1. Quiz produced by pupil using Microprimer program

Much software strengthens the view that microcomputers have no contribution to make to language development. However, programs are now appearing which offer far more than just 'barking at video'.

Since many computer aided learning programs are written by people with a mathematical or programming background, it is not surprising that those developed for language work concentrate more on denotation rather than connotation.

While the first part of this article concentrates on such programs and the second part looks at more open-ended approaches, the major program discussed, *Tray*, is an outstanding example of how the microcomputer can develop pupils' feeling for the structure and meaning of language.

Programs exist which test spelling either by displaying a word for a fixed period of time and then asking the pupil to type it on the screen, or by drawing pictures and asking for the appropriate word. The first technique merely tests short-term memory, while the second presupposes that a picture demands a noun rather than an adjective, phrase or sentence. One early version of picture naming gave two screens full of detailed instructions to pupils who were then asked to spell such words as 'cat' or 'dog'! It would probably be cheaper and easier to buy a device such as 'Speak and Spell' now that the spelling has been anglicised, rather than using a £400 computer.

Children develop language by talking, listening, reading and recording. Adventure games (such as that reviewed by Charles Bake in April's *Acorn User*) are a good source of stimulation for creative or descriptive writing, or for creating situations beyond pupils' experience. Ideally, the teacher or pupil should be able to alter the hazards and rewards to make them relevant to particular pupils, or to develop particular aspects of language.

Hangman is a popular computer game which can help with spelling and word recognition. Good versions allow for some progression from easy to hard words and give the user some way of altering words, allowing the teacher to match topics pupils are studying or to help reinforce words from the reading scheme. The best versions allow for input of words and clues, and this is particularly valuable when it is the pupil who enters the data rather than the teacher.

If a game has a series of rewards and punishments, the effect is lost if the punishment, eg, being eaten by the technicolour monster which growls and belches, is far more attractive than the reward of 'Well done, Sally'.

Games can have the advantage of encouraging group discussion. *Hangman* is much more valuable if a group works together and must reach unanimous decisions before letters are entered.

The focusing of attention on the monitor screen can oil the social wheels. Because eye contact can be safely avoided even the most introvert child is able to put a point of view. This aspect is especially

Heather Govier of a microelectronics advisor to the London Borough of Croydon. Series consultant is Paul McGee.

important with poor readers with a record of failure and a low self-image.

Communicating with a computer may seem a surprising route to improving communication between people, but the computer's demand for precision can be used to good effect. Pupils who use information retrieval systems find that they learn to be less precise if their enquiries produce too few possible responses, and more specific if too many responses are found. Similarly, they have to consider synonyms if the particular information they want does not seem to be present in the database.

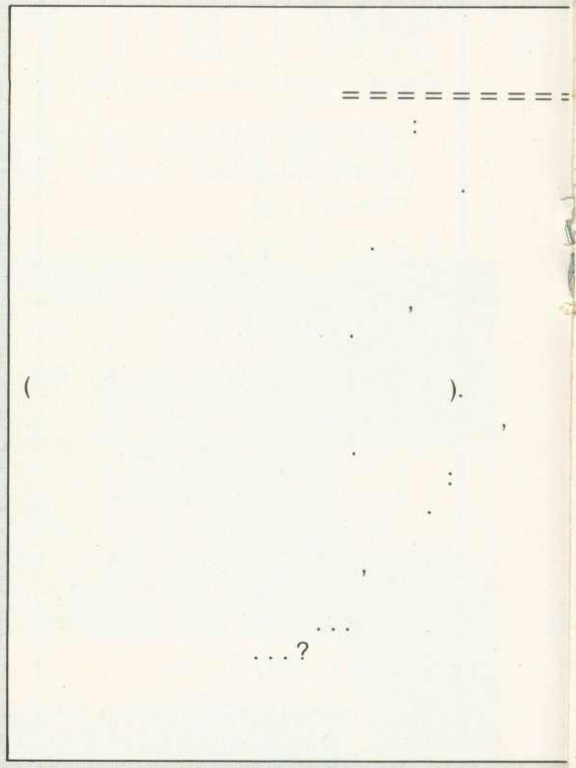
One pupil using a quiz program, very similar to the one provided in the Microprimer package, produced the quiz which is illustrated in figure 1. The Croydon version of *Quiz* also allows pupils to enter a range of comments which appear when users obtain particular scores. They realise that an expression may seem humorous when used once but can become irritating when used frequently, and this is made clear to them by their fellow pupils rather than the teacher.

Teachers are sometimes reluctant to correct all the grammatical errors, spelling mistakes and poor choice of words for fear of disheartening their pupils. Similarly, pupils dislike rewriting work and so rarely see a well-finished piece of work. Word processing systems can provide the environment in which pupils are willing to continually improve a particular piece of text until it is satisfactory.

This assumes that schools have discs and printers. A further use for these peripherals is in cloze testing, where the disc is used to record all of the pupil's responses and this uses the teacher's time more effectively.

Problem solving is generally considered to be a mathematical activity, but a fluent reader is a problem solver par excellence. In tackling a complex piece of text, the reader is constantly formulating hypotheses, testing them against the text and revising, accepting or rejecting as appropriate.

Such a reading strategy is difficult to teach because of the complexity of the task and the speed at which such thinking is usually performed. It is difficult to provide a situation in which reading can be slowed down to such a degree that pupils are able to take the process in steps or stages.



Figures 2-4 show an example of *Tray* in action taken from a screen display.
A session starts off with just punctuation, and the text slowly builds up as pupils take a guess on the letter or word. The sequence continues overleaf

It is not surprising that schools have frequently abandoned the effort and once the basic skills have been mastered have left pupils to develop their reading. The traditional comprehension exercise and cloze procedure test rather than teach, although with discussion they may help to extend vocabulary.

The appearance of computers in schools provides a medium for language work which proceeds step by step in the right atmosphere. Pupils need a sense that it is alright to play and safe to experiment. They need a social climate sufficiently relaxed to be capable of exorcising the spectre of the 'right answer', an environment capable of giving house-room to all sorts of shy little insights most of which will turn out to be wrong but many of which will have a useful, indirect part to play. Pupils also must have some equally 'green' colleagues to compare notes with. Others may see alternative possibilities and in discussion all participants are called upon to defend and explain their preferred interpretations.

The program *Tray* combines all these factors to create a new dynamic approach to the teaching of reading. *Tray* is a sort of Hangman activity, but to describe it thus, fails to do justice to its use and potential. A piece of text is stored in the computer but remains hidden from the readers as though it were an undeveloped photographic print. The pupils are able to bring up the text a little at a time in the developing tray. As it is slowly revealed the readers are called upon to hypothesise about the meaning, initially with inadequate information. Thus their comprehension grows slowly through a series of false starts and blind alleys until a final consensus is reached.

While the ideal size of group is about half a dozen the program has been used satisfactorily with a full class, and once children have become familiar with the activity there is no need for the teacher's constant presence. The program was developed for remedial readers in secondary schools but can also be used with primary pupils, although the abilities of pupils in the group should not be too disparate for maximum collaboration.

The program has a scoring system which uses a jackpot. Initially the jackpot is 26 and falls

```
= = =,
```

```
 T     T   E        = = = = = = = = = = =,
    E    T E                  :
T E  E   E                E E
  E    E     ET                 .
T          T E  T          E T    T
            EE T  E       T .
T E   EET
              E          T  E ,
           T     TE    E .
T E       E       E
(T  E T      T T  E             E  E ).
    ET   E        E          E        E ,
        T  E E                .
T E  T E  T E                       :
 T'    E   T E   E      T      .

   T  HOSE      T       E ,
                   E T  E                 E
   E T  E  T  E       T . . .
    T  E             . . . ?
```

```
 T   RI T      E  R     = = = = = = = = = = =,
  R  E  I  THE  IR           I :
THE  E    E  R       HERE
 RE      E      ET                 .
THR     H THEIR TR        RE  T    RT
           EE THEIR     T .
THEIR  EET R
              E     RI    T   E ,
  R    ITH   HITE  I  E .
THE  H   E     R E E
(THE T      T THE          RE RE  ).
    ETI  E        E I       E        E ,
HI   I TH E E       HI    .
THE  THE   THER                        :
IT'S    E  R THE  RE    E  T HI  .

  T TH    E       T  H    E ,
 H            I   I  E THEIR H  R        IE
 RE THE  THEIR     T . . .
 R THEIR   R  I    . . . ?
```

by one each time a letter is bought. When the pupils reach the stage of being able to predict letters, they win a number of points calculated against the current jackpot level. Thus early predictons are rewarded more highly than late ones.

For predicting a single letter the group can win only one point. For predicting a word or phrase they can win as many points as there are letters in the word, plus a quarter of the jackpot for each letter. Thus they are encouraged to be bold and predict larger chunks of text. Penalties for failure are arranged so as to promote the same strategy.

When the jackpot falls to 16, and again after every two jackpot points have been lost, the pupils are invited to write a brief telegram on what they think the message is about. This requirement forges a link between reading and writing. The process of phrasing a telegram forces the pupils to question their current understanding. The program is able to store all telegrams and present them at the end of the session to allow the pupils to review the emergence of their understanding.

The pupils were a group of six third year junior children who were working with a teacher away from class distractions in the school library. The pupils were introduced to the text as a blank screen except for punctuation marks (see figure 2). The workings of the cursor, which can be used as a pointer, were explained to them and the task introduced as a game of Hangman. At the outset the team were given a budget of 50 points and told that they might buy a letter for 10 points. In considering which would be the best letter to buy there was much discussion about vowels and about which was the most usual vowel, resulting in a communal decision to buy the letter 'e'.

In discussion over which letter should be bought next 'a','r' and 's' were suggested. When one child said, 'Who votes for "a"?' the teacher introduced the group to the consensus politics of the game. If a vote were taken some pupils would be disappointed and thus it was agreed that a letter would be chosen only if all pupils agreed.

Pupils were encouraged to think now in terms of words rather than just letters and to ask themselves which words are common. 'The' was felt to be the most common word and after discussing the relative merits of buying 'h' or 't' the letter 't' was finally chosen. The jackpot was now 24, the team had 30 points and the text looked like figure 3.

Now some pupils began to spot words. Was that 'feet' in the seventh line down? Where could they predict 'h'? After several possible the's had been pointed out the best bet was felt to be the one which began a phrase at the beginning of line three.

'The' was predicted correctly and the computer instructed to reveal all further instances of the same triplet of letters (this can be done at no further cost). Fifteen instances of 'the' were counted although they could be parts of words such as 'there', 'they' or 'either'. Someone spotted the apostrophe in line fifteen and 'it's' was predicted followed by 'here' in the third line of text. All the 'r's and 'i's were now taken giving a text which looked like figure 4. Focus was immediately turned to 'their' with much discussion as to its meaning. 'Their feet' seemed a likely combination and was successfully predicted and after taking 's' a combination 'Th_se' was spotted. What could it be: 'These' or 'Those'? 'Yes, but we've had all the "e"s' said one girl, 'so it must be "those"!'

This type of good thinking and

checking is seen throughout a session with *Tray* and is just as apparent with groups of pupils as it is with adult groups such as teachers. Teachers, as with all aspects of computer use, exercise more caution and are more inclined to be reticent when asked to theorise. The scoring system encourages the more adventurous approach.

Successful prediction of 'a tourist' in the first line added a new dynamism. Now it was possible to speculate about the general meaning of the passage. 'Perhaps it is about visitors to America or Hollywood?'

There was much discussion about the word hidden by the stars. It was explained that this word had been deleted from the passage and would not appear even at the end of the exercise. Perhaps this hidden word indicated where the tourist had come from. It clearly had a lot of letters and so the children tried to think of long place names. Could it be Switzerland or Australia?

Suddenly it became possible to spot words and phrases. 'Are these their boots' was suggested for the penultimate line but after careful counting 'boots' was seen to be too long. Was that 'around here' in line three? Perhaps line five read 'you can see their huts'?

This led to much discussion about whose 'huts' they were until a bit of good checking was exhibited when some one said 'No we've had all the aitches it can't be "huts".' Perhaps it was 'nuts'! All agreed on 'you can see' and a successful prediction was made. The score now stood at 123 but not many of the pupils were still interested in it. The task had become so engrossing that the score had now become almost irrelevant.

After taking 'n' the screen looked like figure 5. Ideas began to pour in thick and fast. 'In', 'around' and 'transparent' were spotted and the opening was read as 'A tourist came from'. The last two words seemed to be 'their reins'. Perhaps the passages was about 'asses'. But how should reins be spelt? No, the spelling was wrong. Reins must be something else, anyway wasn't there a letter missing? It could not be 'trains' because 't's have gone, could it be 'brains'?

This level of thinking and

```
A TOURIST   A   E   RO    = = = = = = = = = = =,
 AR  E   I   THE AIR A     SAI  :
THE   EO    E AROU      HERE
ARE   A  E O      ETA  A          ASS.
THROU   H THEIR TRA   S  ARE  T   ARTS
 OU   A   SEE THEIR    UTS.
THEIR FEET RO
O     O           EASURI      TA  ES,
 AR      ITH     HITE   I  ES.
THE   HA  E   OUR E  ES
(THE T   O AT THE    A      ARE RE  ).
SO   ETI    ES A S  E  IA   O  E  ASSES,
HIS   I  TH E  E     ASHI     .
THE    THE OTHERS S  O      O     :
IT'S      EAR THE    RES  E  T HI   .

  UT THOSE SO  T SHA  ES,
SHA  O       I  SI   E THEIR HAR      O  IES
ARE THE    THEIR    UTS. . .
OR THEIR    RAI   S. . . ?
```

Figure 5. From this pupils were encouraged to explain the story in a telegram.

```
A TOURIST CA
PAR  E   IN TH
THE PEOPLE A
ARE   A  E O
THROUGH TH
YOU CAN SEE
THEIR FEET R
ON   ON   M A
 AR   WITH WH
THEY HA  E   O
(THE T   O AT T
SO   ETI   ES A
HIS   I  TH E  E
THEN THE OTH
IT'S     EAR THE

  UT THOSE SC
SHA  O      INS
ARE THEY THE
OR THEIR    RA
```

Figure 6. Telegram ti
Is the tourist from Au
Are the people museu

Figure 7. ET-inspired theory of a visitor from space?

```
A TOURIST CAME FROM = = = = = = = = = = =,
PARKED IN THE AIR AND SAID:
THE PEOPLE AROUND HERE
ARE   ADE OF    ETAL AND    LASS.
THROUGH THEIR TRANSPARENT PARTS
YOU CAN SEE THEIR    UTS.
THEIR FEET ROLL
ON LON    MEASURING TAPES,
DAR   WITH WHITE LINES.
THEY HA  E FOUR EYES
(THE T   O AT THE    A      ARE RED).
SO    ETI    ES A SPE   IAL ONE PASSES,
HIS FIFTH EYE FLASHIN   .
THEN THE OTHERS SLO     DO    N:
IT'S    LEAR THEY RESPE    T HI   .

  UT THOSE SOFT SHAPES,
SHADO    Y INSIDE THEIR HARD    ODIES
ARE THEY THEIR    UTS. . .
OR THEIR BRAINS. . . ?
```

Figure 8. The correct
One child felt conne

```
A TOURIST CA
PARKED IN TH
THE PEOPLE
ARE MADE OF
THROUGH TH
YOU CAN SEE
THEIR FEET R
ON LONG ME
DARK WITH W
THEY HAVE F
(THE TWO AT T
SOMETIMES A
HIS FIFTH EYE
THEN THE OT
IT'S CLEAR TH

BUT THOSE S
SHADOWY INS
ARE THEY TH
OR THEIR BRA
```

T CAME FROM = = = = = = = = = = =,
N THE AIR AND SAID:
LE AROUND HERE
O ETA AN ASS.
THEIR TRANSPARENT PARTS
SEE THEIR UTS.
T RO
MEASURING TAPES,
H WHITE LINES.
E OUR E ES
AT THE A ARE RE).
ES A SPE IA ONE PASSES,
E E ASHIN .
OTHERS S O O N:
R THE RESPE T HI .

E SO T SHAPES,
INSI E THEIR HAR O IES
THEIR UTS. . .
RAINS. . . ?

am time again.
m Australia?
useum models?

rrect text.
nned, but exhilarated.

T CAME FROM = = = = = = = = = = =,
N THE AIR AND SAID:
PLE AROUND HERE
E OF METAL AND GLASS.
H THEIR TRANSPARENT PARTS
SEE THEIR GUTS.
ET ROLL
MEASURING TAPES,
H WHITE LINES.
E FOUR EYES
AT THE BACK ARE RED).
ES A SPECIAL ONE PASSES,
EYE FLASHING.
E OTHERS SLOW DOWN:
R THEY RESPECT HIM.

SE SOFT SHAPES,
Y INSIDE THEIR HARD BODIES
THEIR GUTS. . .
BRAINS. . . ?

reasoning permeated the whole session which lasted uninterrupted from 1.30 to 3.45 pm. All the pupils chose to work through break time and some wanted to stay after school.

In this session it was getting close to telegram time. What could the group now read of the text? What did it all mean? They were encouraged to try to read as much as they could substituting a nnnnnn for the words which they could not guess. With nothing more than figure 5 to support them the group read:

> 'A tourist came from nnnnnn in the air and said the people around here are nnnnn nnnnn and ass through their transparent parts you can see their cuts, their feet nnnnn on treasuring tables (no! measuring tapes) number with white lines.'

They constructed a telegram:

> 'We think it is about a tourist who measures with tapes'.

What sort of people, they wondered, had transparent parts. Were they models in a museum? Perhaps you could see their 'guts' not their 'cuts'. It must be 'guts' because 'cuts' would be on the skin and if you can see through them . . .

The phrase 'parked in the air' was spotted in line two leading to much speculation on how someone could park in the air. The tourist must be in an aeroplane, a helicopter, a balloon, a hovercraft or a jump jet.

By the time the second telegram was required the screen looked like figure 6. The final section had been laid open and the telegram read:

> 'We think it is about a tourist who came by plane from Australia, who measured hard bodies with dark tapes with white lines, and she or he didn't know if it was their guts or their brains.'

There was thus still much confusion but the group hung tenaciously to the theory that the tourist came from Australia (despite the fact that the letter count was wrong) and that these strange people were museum models.

By the time the screen looked like figure 7 it had become possible to read almost everything. The 'special one' was like a commander who ruled the others. But who were these strange people? Where had they ever seen 'people' whose 'feet' roll on long measuring tapes, dark with white lines? 'Perhaps they have wheels – these people are they cars?' 'Yes!!'

Suddenly it all made sense. The space tourist comes to earth and mistakes the cars for the inhabitants. The measuring tapes are the roads and the 'special one' with the 'fifth eye flashing' is a police car.

'Oh what a con!' shouted one pupil but the pleasure and satisfaction was there on the faces of all of them. All were amused and intrigued by the final question:

> But these soft shapes
> Shadowy inside their hard bodies
> Are they their guts
> Or their brains?

There was no doubt that the session had been exhausting for pupils and teacher alike but everyone involved left with a feeling of exhilaration. (The correct text is shown in figure 8.) By taking things slowly, and working collaboratively in a relaxed non-censorious atmosphere this team of nine-year olds had been involved in a process of deep text analysis rarely seen in the primary school.

The process had required the simultaneous application of analytic, convergent thinking as well as creative thought. Pupils had to combine both styles and everyone's talents were used to the full.

Pupils quickly learn to doubt their first hypothesis

One of the most clear-cut effects of repeated use of *Tray* with a group of pupils is that they quickly learn to doubt and question their first hypothesis, becoming more open to alternatives. With this, their first experience of using *Tray*, it was a long time before someone suggested that these were beings from a different world, that the tourist came from outer space and

that the spaceship had been parked in the air because there was no gravity.

Tray does something more than all other current software designed for language work. It allows children to read in a new way, a way both magical and powerful. It is based upon the assumption that

Tray allows children to learn in a new way

good reading and writing often grow best rooted in a rich subsoil of good talk, and links reading with talking, listening and writing.

Tray thus brings to language work much of what Logo brings to maths. Readers are set in a 'microworld' where:

- even mistakes become profitable learning experiences;
- a trial and error approach is possible allowing exploration with a structure imposed from inside rather than outside the group;
- discussion and hypothses testing are possible at all levels from the simple spotting of words to the complex analysis of deep meaning;
- final understanding results from combined analysis and synthesis using elemental building blocks.

Further, it encourages co-operation in an atmosphere in which it is recognised that everyone has a valuable contribution to make. This is an important aspect of *Tray*. By requiring consensus the teacher encourages the members of the team to argue their point of view, explain and persuade. Through such a process, weakly thought out ideas are tested and more strongly supported ones tend to be adopted. This may lead to problems when a well reasoned and strongly supported hypothesis is opposed by a new more powerful one. In text analysis, as in science or maths, individuals find it very hard to abandon their theories, clinging tenaciously to them even against mounting evidence. Perhaps it is this last point which most of all makes *Tray* a significant new teaching tool.

Tray consists of a program to play the game and keep the score as well as a program to allow the user to set up text files. These files are separate from the program and can be stored on cassette or disc for later use. The teacher can thus create a piece of text which fits in well with current classroom activities so that the emphasis can be on the meaning rather than the spelling of individual words.

The initial version of the program was developed on a computer which used capital letters only. This is unacceptable as pupils should see text presented on the screen in a way that is as close to normal text as possible. Thus letters should have true descenders and upper and lower case letters made available. *Tray* is now being developed as part of an MEP project, Developing Thinking Skills in Primary School, which is based at the Davidson Centre in Croydon. Teachers who are interested in taking part in the serious evaluation of this program should contact Heather Govier.

Even when schools operate on integrated days, pupils rarely get the opportunity to pursue a task uninterrupted over a long period of time. Use of this program shows that when the task is sufficiently

Pupils can rarely pursue a task uninterrupted over a long period

absorbing pupils are perfectly capable of persevering with full concentration for three hours or more.

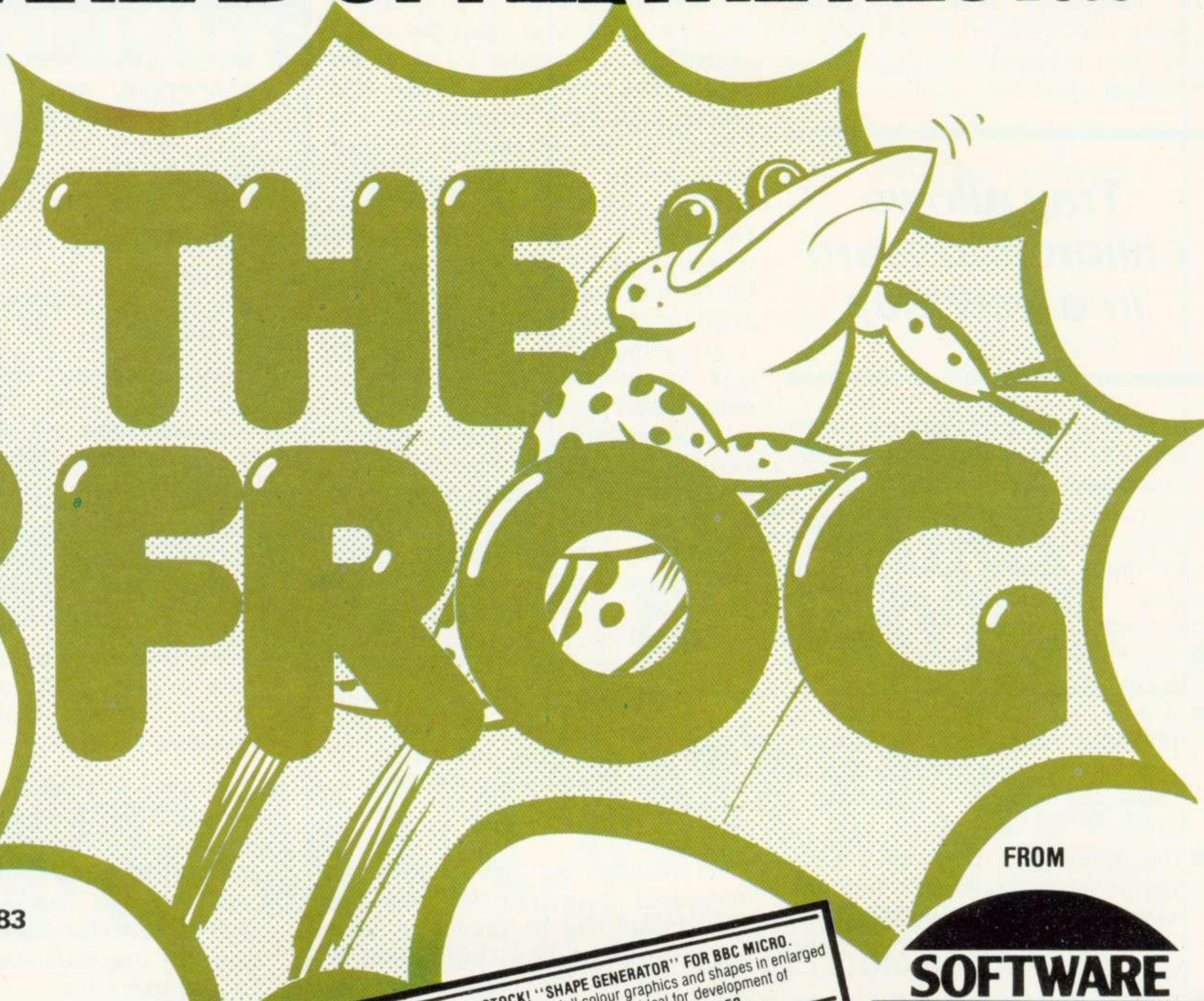
On Inset courses the same happens with teachers who happily abandon their coffee break and have to be reminded to stop for lunch. It is also interesting to note that the same text can be used for teachers and pupils alike.

TEN POINTS TO NOTE

- **Language development is concerned with improving pupils' abilities to talk, listen, read and record. Clearly identify which of these is helped by a particular program.**
- **Do not accept any program which does not use upper and lower case when the pupils could.**
- **Poor readers should not suffer additional difficulties so check that the screen and the printer use true descenders.**
- **Ensure that programs have instructions written at an appropriate level of difficulty.**
- **Some games, particularly adventure games, can stimulate pupils to increase their range of vocabulary and creative writing.**
- **The easy availability of word processing could revolutionise the relative importance of mechanical and creative writing skills in the same way that calculators dramatically change the balance of skills in mathematics.**
- **Information retrieval systems can help to develop pupils' linguistic ability because of the need to refine the criteria for searches.**
- **The computer's role as a neutral referee and score-keeper can provide the reassuring framework for pupils to undertake complex reading and interpretive tasks.**
- **Reject programs which purport to teach spelling but essentially test only short term memory.**
- **Avoid games which 'reward' mistakes by giving a more exciting display than that for correct responses.**

Next month: Information technology in the curriculum

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8 St Georges Arcade
Falmouth, Cornwall
FAREHAM COMPUTER CENTRE
56 High Street, Fareham
Hants PO16 7BG
GALAXY VIDEO LTD
60 High Street
Maidstone, Kent
GAMER
24 Gloucester Road
Brighton BN1 4AQ

GAMES WORKSHOP
Unit 37
Birmingham Shopping Centre
Birmingham B2
GRAVESEND HOME COMPUTERS
39 The Terrace
Gravesend, Kent
KANDYS
40 High Street
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79 Ratcliffe Gate
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MICROSTYLE
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Lansdowne Road, Bath
MICROWARE
5 St Peters Lane
Leicester
MODEL PLUS
55A West Street, Boston
Lincolnshire PE12 8QN
NORTHERN COMPUTERS
Churchfield Road
Frodsham, Cheshire
OFF RECORDS
Computer House
58 Battersea Rise
Clapham Junction, London
RMK ELECTRONICS LTD
Hinton House, Station Road
New Milton, Hants BH23 6HZ

RAM ELECTRONICS (FLEET)
106 Fleet Road, Fleet
Hants GU13 8PA
RDS ELECTRICAL LTD
157-161 Kingston Road
Portsmouth, Hants PO2 7EF
RITCHIE ELECTRONIC
31 North Parade
Bradford, West Yorkshire
STORKROSE LTD
44 Shroton Street
London NW1
SUPERIOR SYSTEMS LTD
178 West Street, Sheffield
South Yorkshire S1 4ET
SOUND ON SOUND
64 Lawton Street
Congleton, Cheshire CW12 1RS
STATACOM LTD
234 High Street
Sutton, Surrey
TECHNOMATIC LTD
17 Burnley Road
London NW10
TOMORROWS WORLD
Esplanade, Lerwick
Shetland Isles
THE VIDEO PALACE
62 Kensington High St.
London W8
WATFORD ELECTRONICS
33/35 Cardiff Road
Watford, Herts WD1 8ED
YORKSHIRE MICROCOMPUTERS
28 Ramshill Road, Scarborough
North Yorkshire YO11 2QF

Having covered 1 MHz bus theory, Paul Beverley gets down to practice

INTERFACE BOX FOR THE BEEB

Having looked at the theory of hardware connections for the 1 MHz bus, here is a practical application – an interface box for the BBC micro. This brings out both user and printer ports as well as adding two fast eight-bit analogue to digital converters (ADCs) and two eight-bit digital to analogue converters (DACs) so you can output voltages. You may wonder about adding two more when there are already four in the machine with higher resolution – 12 bits as against eight. The point is that the on-board converters are extremely slow – each one takes 10 milliseconds (ms) to work out the digital equivalent of the voltage applied to it. This means it is virtually useless if you want, for example, to look at a voltage waveform and display it on the screen – like a digital storage scope. The ADCs used in this interface box can do a conversion in about 10 microseconds (µs). They are only guaranteed to work at a clock rate of 600 kHz, giving them a conversion time of 15µs, but if run at 1 Mhz they do a complete conversion in 9µs. Despite the quoted maximum clock rate of 600 kHz, the ZN427s I have tried work at 1 MHz. Using 1 MHz is convenient because the bus we are using has, as its name suggests, a supply of 1 MHz clock pulses readily available.

Figure 1 shows the address decoding used. It places the two DACs at &FCF0 and &FCF1, and the two ADCs at &FCF2 and &FCF3. Those who read last month's article may well have noticed one or two deliberate mistakes. For example, I suggested that when connecting up the address lines to enable various devices, you could connect directly from a 74LS138 address decoder to the chip select lines of the converters. This works with the ZN428 because its chip select line is negative active, but the ZN427 has an 'output enable' input (pin 2) which is in fact *positive* active, and not negative active as suggested. Therefore, since the lines from the 74LS138 are normally high, and only go low when the particular address appears on the address lines, we have to invert them before applying them to the output enable lines of the ADCs.

Since we have to put an extra inverter into each line anyway, we might just as well add a third gate as suggested last month to gate these output enable pulses with the read/not-write (R/NW) line on the bus. This ensures the outputs of the ZN427 are only enabled when you are trying to read them. Thus if you accidentally try to write to the ADC you won't get the problem of the data bus drivers and the ZN427 trying to write different things onto the same data bus!

Another mistake in the last article concerns the read/not-write line. Following Acorn's Application Note on the 1 MHz bus, I said this was just an extension of the read/not-write line of the main 6502 processor with extra buffering. In fact it only ever goes low (= write) when you are trying to write to a device on the bus. This doesn't make a great different practically, but we might as well know the truth. This will avoid any confusion which might have arisen if, when fault-finding the interface box, you had looked at the 1 MHz bus read/not-write line. You would have expected to see a continuous train of pulses as on the processor's read/not-write line, but would have found it was sitting at logic 1 unless the bus was being accessed.

The decode logic also provides four spare lines – &FCF4 to &FCF7. Two of these can be used to provide 'start convert' pulses for the ADC's since if you read or write to, say, &FCF4 then the 'NFCF4' line (figure 1) will go low for just a

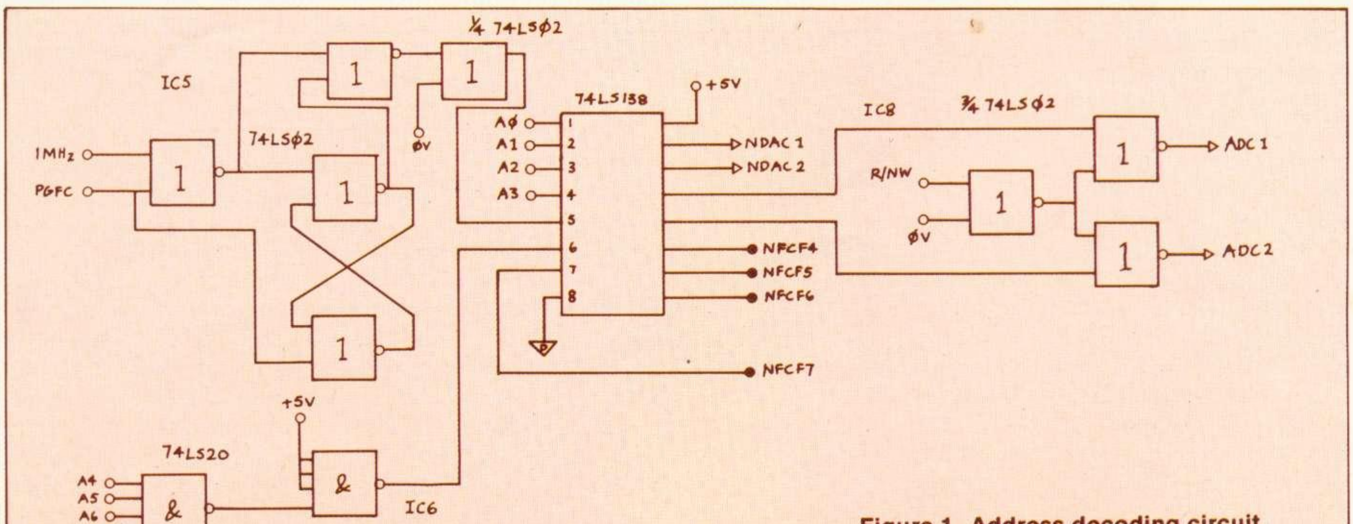


Figure 1. Address decoding circuit

go low for just a fraction of a microsecond – but long enough to initiate the conversion. If the system clock is being used for the conversion, there is no real need to use the 'end of conversion' (EOC) output of the analogue to digital converter since, because we are using the 1 MHz clock signals, we know conversion takes 9μs. If you really want to use the EOC signals, either attach them to the input lines of the user port, or to the two spare digital input lines on the analogue ports (15 way D-type connector) which go to the internal versatile interface adaptor at &FE40.

34-way connector 1 MHz Bus		26-way connector Printer Port	20-way connector User Port
1 - GND	27 - A0	1 - CA2	1 - +5 volts
2 - R/NW	28 - A1	2 - GND	2 - CB1
3 - GND	29 - A2	3 - PA0	3 - +5volts
4 - 1MHz	30 - A3	4 - GND	4 - CB2
5 - GND	31 - A4	5 - PA1	5 - GND
6 - NNMI	32 - A5	6 - GND	6 - PB0
7 - GND	33 - A6	7 - PA2	7 - GND
8 - NIRQ	34 - A7	8 - GND	8 - PB1
9 - GND		9 - PA3	9 - GND
10 - NPGFC		10 - GND	10 - PB2
11 - GND		11 - PA4	11 - GND
12 - NPGFD		12 - GND	12 - PB3
13 - GND		13 - PA5	13 - GND
14 - NRST		14 - GND	14 - PB4
15 - GND		15 - PA6	15 - GND
16 - ANALOG IN		16 - GND	16 - PB5
17 - GND		17 - PA7	17 - GND
18 - D0		18 - GND	18 - PB6
19 - D1		19 - CA1	19 - GND
20 - D2		20 - GND	20 - PB7
21 - D3		21 - NC	
22 - D4		22 - GND	
23 - D5		23 - NC	
24 - D6		24 - GND	
25 - D7		25 - NC	(NC = no
26 - GND		26 - NC	connection)

Figure 3 – Pin Connections on the various connecting cables

Another point which hasn't been made strongly concerns the problem of what the Application Note calls 'possible address decoding spikes which may occur during the 1 MHz high'. The inference drawn from this was that it was not a problem unless you were trying to attach a lot of devices onto the bus, for example if you were interfacing to an extra memory board. Indeed I had successfully attached two DAC's and an extra 6522 VIA onto the bus without becoming aware of the seriousness of the problem. The reason for such blissful ignorance was the use of the DAC 0800 chips which cannot be directly interfaced to the bus and I was therefore using two 74LS374 octal latches to read them. This created no problem because these chips are clocked on the positive-going edge of the clock pulse. (So here's another deliberate mistake – I said that the 74LS374 was clocked on the negative-going edge of the clock pulse!) What you have to do then is to use one of the circuits given last month to 'clean up' the select line for page &FC (NPGFC) before applying it to the 74LS138 decoder (figure 1).

The *User Guide* does not make it desperately clear which pins on the various connectors are which. All it gives is a circuit diagram from which you have to count the pin numbers. Figure 3 shows clearly which are which. Note that on both the user port and the printer port there is an earth line inbetween each signal line for screening. However, on the printer port they are the even numbered pins; on the user port the odd numbers.

The operational amplifiers on the inputs of the ADCs are just unity gain amplifiers to provide a higher input impedance and to prevent the ZN427 chips being blown by excessive voltages. If you apply too large a voltage to the analogue inputs you just blow up the 741s instead which are somewhat

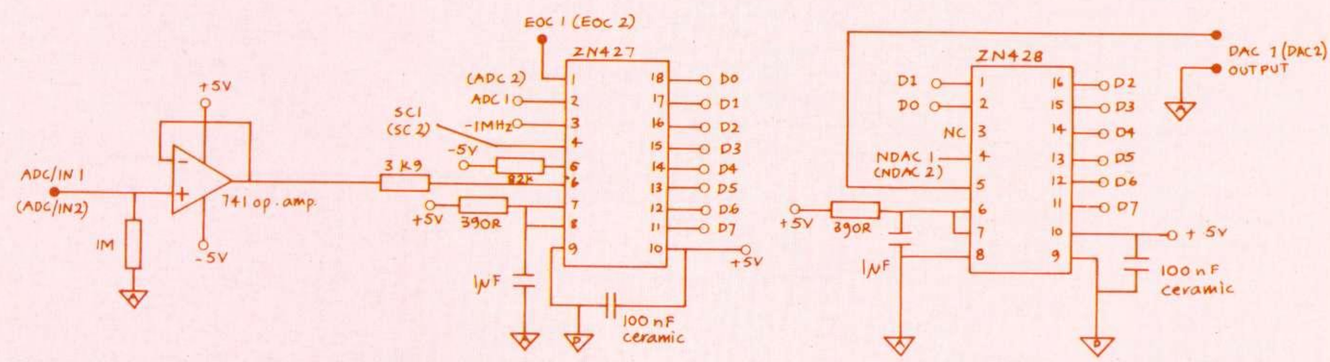


Figure 2. Analogue to digital converters (DAC notation in brackets)

cheaper (14p instead of £7). The outputs of the DACs could be protected in the same way by adding the same operational amplifier circuits, but I have not bothered since I feel it is less likely to do something silly with an output.

A parts list (figure 4) is given for the main circuits, including printer and user port connectors, but excluding any protection on the DACs. Most parts can be bought easily from RS Components, but more cheaply elsewhere if you shop around. You can make the circuit up on Veroboard, but the company mentioned in the parts list will give you details of a printed circuit board, kit of parts or a built and tested board.

The other thing missing from the parts list is the box in which the unit is to be housed, and the sockets to connect up equipment, because these will differ according to your application. In my college for example 4mm sockets are the standard.

Semiconductors				**Cost**
2	ZN427	A to D converters	(309–464)	13.16
2	ZN428	D to A converters	(303–523)	9.56
1	74LS138	3 to 8 line decoder		0.27
1	74LS20	2 x 4-input NAND		0.13
2	74LS02	4 x 2-input NOR		0.22
2	741	Operational amplifier	20p ea	0.40
Capacitors				
4	1uf	polyester	42p ea	1.68
4	100 nF	ceramic	7p ea	0.28
8	10 nF	ceramic	4p ea	0.32
Resistors				
2	1M			
2	82k		2p ea	0.20
2	3k9			
4	390R			
Hardware				
1	20-way jumper lead with DIP socket			1.85
1	26-way jumper lead with DIP socket			2.10
1	34-way jumper lead with DIP socket			2.70
1	20-way transition connector		(468–147)	1.44
1	26-way transition connector		(468–153)	1.80
1	34-way transition connector		(468–169)	2.30
2	18-way DIL sockets		16p	0.32
3	16-way DIL sockets		11p	0.33
3	14-way DIL sockets		10p	0.30
2	8-way DIL sockets		9p	0.18

Veroboard or PCB

PCBs, kits of parts and fully built and tested boards are available from: Electro Technical Services 55 Raymond Road, Hallesdon, Norwich, NR6 6PN (see page 64)

Figure 4 – Parts List

With this interface box you are mixing analogue and digital signals, so care is needed with supply lines and earth lines. In particular it is important that parts of the circuit which require an analogue earth – marked on figures as an earth symbol with an 'A'in it – should not be connected to the line which is supplying the zero volts to the various chips on the boad. I have referred to this as the digital earth . It is also important to decouple the supply effectively. Each chip should have a 10nF ceramic capacitor connected across its supply lines as close to the chip as possible. In the case of the ADCs I have used 100nF. Operational amplifiers should have 10nF capacitors on the positive and negative supplies.

This brings me to power supplies. Where are you going to obtain the +5 volts and -5 volts to power these circuits? There is a +5V supply on the user port, so with a separate external supply for the -5V there is no problem other than choosing a suitable connector. As an alternative, there is an outlet on the BBC micro's own power supply unit which has both supplies as well as +12 volts. These are intended for disc drives, but the power we need is fairly small. The ony problem is getting hold of the appropriate connector. They are not the same as the six pin QM multipole connectors in the RS Components catalogue even though they look similar. In fact they are made by A-MP and are distributed by Ampliversal of Terminal House, Stanmore, Middlesex.

There is another slight problem for those using a disc drive that does not have its own power supply. You will need to get yourself a suitable socket as well as a plug to take power from the PCB to the disc drive. If you buy the board from Electro Technical Services, there should be no problem as there is space on it for a board mounting plug.

In designing the front panel you will have to decide exactly which facilities to provide. I have included the BBC's four ADC inputs, the spare digital inputs used by the paddles and the lightpen strobe input, all of which can be brought up on a multi-way screened cable from the 15 way D-type connector that plugs into the back of the computer. Various other lines from the 1 MHz bus have also been brought out to sockets. For example, the analogue input is a useful tool for 'listening' to what the computer is doing. If you put one finger on, say the interrupt line (NIRQ) and another on the

page 64▶

SOUND OUT OF AN ATOM

For £20, you can build David Tilston's sound board and produce effects, including envelopes, to rival the BBC micro

The AY38910 sound generator is a readily available chip which at around £6 offers all that is needed for the generation of fairly complex sound effects, such as gunshots, space sirens, helicopters and explosions.

The PSG (programmable sound generator) contains three separately programmable output channels: a white noise source, two eight-bit I/O ports and full ADSR (attack, decay, sustain, release) control of the output. It can continue to produce sound after the initial commands have been given, thus releasing the host processor for other tasks.

The circuit diagrams and software illustrated in this article will allow Acorn Atom owners to use this chip to add special effects to their favourite programs. The circuit can be constructed with a minimum amount of effort using only a handful of readily available components, for about £19.

The circuits makes use of the Atom's two I/O ports and requires the 6522 chip to be fitted inside the Atom; it uses the eight lines of port-B and lines PA0, PA1 of port-B. The only other components needed to interface this IC are an audio amplifier circuit, which can be created easily by the use of an LM386 audio amp IC.

- 64-way A&B Eurocard connector with right angled pins (or wire-wrap pins) to fit PL6 on the back of the Atom.
- 64-way A&B Eurocard breadboard with correct patterning for euroconnector type DIN 41612 or DIN 41617.
- AY38910 PSG with data sheets. It is important to obtain the data sheets as they contain all the necessary information on the structure of the PSG, and how to program it.
- 40-pin socket, 8-pin socket, single strand wire.
- LM386 audio amp available from Tandy etc.
- 220 to 500 microfarad electrolytic capacitor, and any small type.
- 10k linear variable resistor, any small type, eg rotary.
- 8-ohm loudspeaker, low power type.

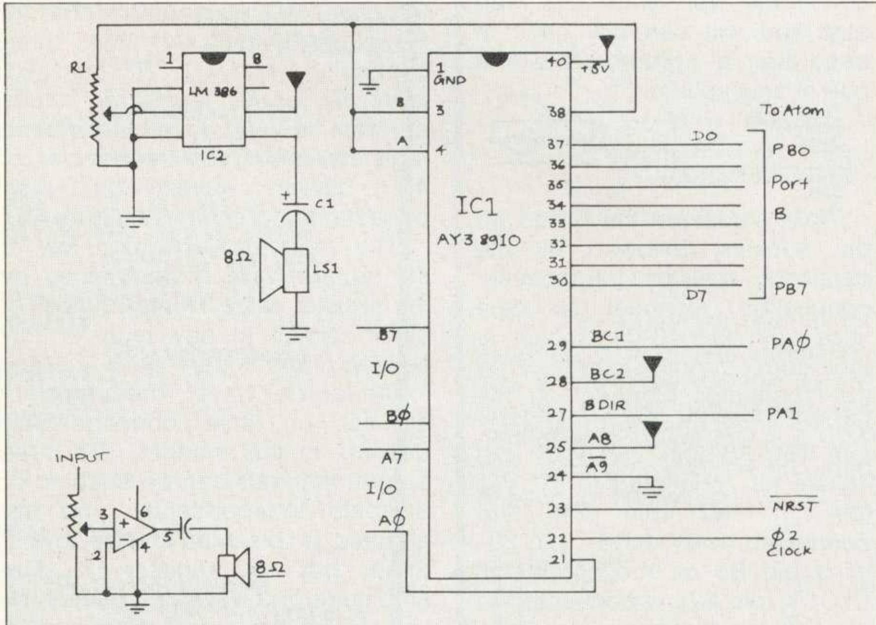
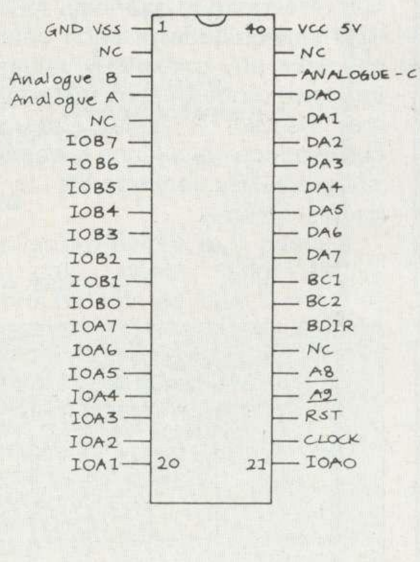
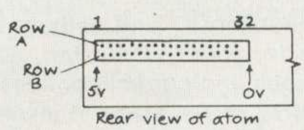


Figure 1. Circuit diagram





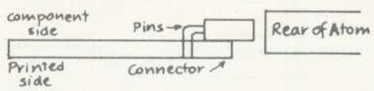
AY-8910	PIN	ATOM	PIN
DA0	37	PB0	A 10
DA1	36	PB1	A 9
DA2	35	PB2	A 8
DA3	34	PB3	A 7
DA4	33	PB4	A 6
DA5	32	PB5	A 5
DA6	31	PB6	A 4
DA7	30	PB7	A 3
BC 1	29	PA0	A 20
BC 2	28	+5V	+ 5V
B DIR	27	PA1	A19
A8	25	+5V	+ 5V
A9	24	0V	0V
CLOCK	22	φ2	B29
NRST	23	RST	B6

Figure 2. Pin configurations

BUILDING THE BREADBOARD VERSION

The circuit can be built on a Eurocard breadboard using the following tools; soldering iron (low wattage with small tip), solder, wire strippers, wire snippers and sharp knife (figures 1 and 2).

First, solder the Eurocard connector onto the Eurocard ensuring correct orientation so the component side faces up and the board will stick out of PL6 (see below). If you have the connector type with wire-wrap pins you will carefully have to bend them at right angles with a pair of small pliers.



Next, solder on the 8 and 40 pin sockets, followed by the capacitor, resistor, loudspeaker connection. Connect all data lines from the 40-pin socket to their corresponding port lines on the connector. Connect all the control lines, ensuring that; BC2 (pin 18), A8 (pin 25), VCC (pin 40),are all connected to 5V. Vss (pin 1), A9 (pin 24), are connected to ØV. NRST (pin 23), joins pin B6 on the connector. CLOCK (pin 22), is connected to pin B29 on the connector. BC1 and BDIR join PAØ and PA1 respectively.

Now complete all the other connections and thoroughly check your work for solder bridges and correct connections.

Now you're ready to insert the AY38910. Do this carefully, taking care not to bend any pins. Avoid touching the pins if possible to avoid static damage to the chip. Then insert the LM386 taking the same care.

PROGRAMMING THE SOUND CHIP

THE programmable generator creates sound by producing square waves on any or all of its three output channels. The faster the rate of the output the faster the rate of vibration and the higher the sound pitch (figure 3).

Frequencies of the square waves on the three output channels are controlled by the three 12-bit tone registers:

Channel A registers R0 and R1
Channel B registers R2 and R3
Channel C registers R4 and R5

Registers R0, R2 and R4 form the lower eight bits of the three channels, while R1, R3 and R5 form the upper four. The values programmed into any of these three registers control the frequencies of the output waves on their corresponding channels (figure 4).

The width of each high low of the square wave is determined by the register value, ie the number of clock cycles in any high or low section of the square wave is equal to the register value. Three registers all act on their corresponding channel in this manner. The three output channels can be enabled or disabled independently, and are enabled or disabled by the lowest three bits of register 7. The amplitude of a wave determines the volume of the sound produced.

The amplitude of each channel is controlled by its amplitude control register (registers 8,9 and 10 correspond to channels A,B and C). The amplitude of each channel can take any one of 16 values (ie the lower four bits of the register are used.) A value of zero corresponds to silence whereas a value of 15 corresponds to the loudest volume.

Listings 1 to 4 give examples of simple tonal effects. Note that program 1 must be entered and run first. If the values in listing 1 for Y are changed in lines 500 and 510, the tone will change in frequency. If the value in line 530 is made smaller the sound will become quieter.

The frequency sweep routine (listing 2) runs through all the possible tones from a single channel, starting from the highest. Changing the step rates in lines 520 and 540 will produce some unusual variations, also changing the wait period in line 560.

On this soundboard, all three channels are connected to the same amplifier. Hence if more than one channel is enabled at a time the resultant wave will be a combination of the channels. It will sound like a chord, rather than a pure note.

Register 7 is used to enable or disable the output channels and the I/O ports (table 1). For example, a value of 240 (11110000 binary) will set port B to output, set port A to output, enable tones on channels A,B and C, enable noise on channel A.

Registers 14 and 15 correspond to two eight-bit input/output ports; A and B respectively. These are simple ports and using the I/O registers has no effect on sound generation.

As well as simple tones, a white noise source can be mixed with the three output channels. Noise creates a hiss smilar to that on a radio which is not tuned. The PSG creates noise by adding small 'glitches' to the output wave. The degree of noise is controlled by register 6, a five-bit register, and so hiss values can be in the range 0 to 31. The mixing of the hiss with the output channels is controlled by bits 3,4 and 5 of register 7 in exactly the same way that the tones are enabled. Noise may be enabled onto a channel independently of

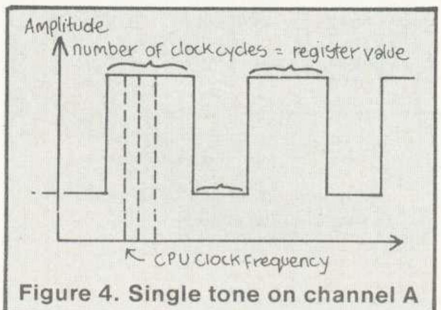


Figure 4. Single tone on channel A

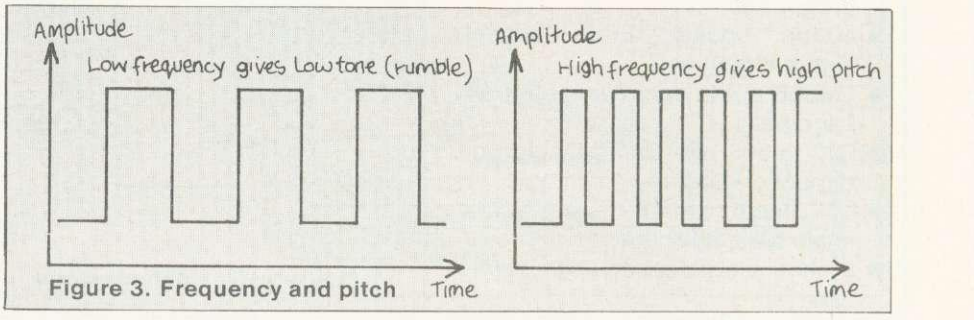


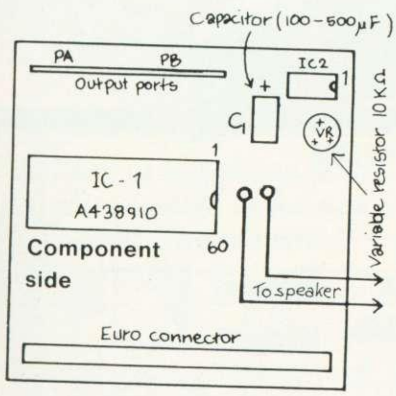
Figure 3. Frequency and pitch

Program 1.

```
10  DIM LL4
20  P.$21
30  P=#2800
40  [
50:LL0
60  LDA @ 03
70  STA #B801
80  STX #B800
90  LDA @ 02
      :latch data
100 STA # B801
110 STY # B800
120 LDA @ 00
      :latch tristate signal
130 STA # B801
140 RTS
145:LL1
150 LDA @ 03
      :latch address
160 STA # B801
170 STX # B800
180 LDA @ 01
      :initiate read
190 STA # B801
200 LDA @ 00
220 STA # B802
230 LDA # B800
240 STA # 80
250 LDA @ 00
      :set bus tristate
260 STA # B801
270 LDA @ # FF
280 STA # B802
290 RTS
300 ]
310 P.$6
320 ?#B803=255;?#B802=255
330 W LL0 ; R LL1
340 END
```

Routine LL0 writes data to one of the AY-3-8910 registers.
x – register no (0 to 15)
y – data (0 to 255)

Routine LL1 reads from the PSG registers.
x – register no (0 to 15)
80 data read from register.



Component side

Component orientation

Listing 1. Single continuous tone

```
500 X = 0;Y = 120; LINK W
              : tone value low byte:
                Channel A
510 X =1; Y = 0; LINK W
              : tone value high byte.
                Channel A
520 X = 7;Y = 254; LINK W
              : enable tone channel A
530 X = 8;Y = 15; LINK W
              : set volume level
                (maximum)
540 END
```

Listing 2. Frequency sweep

```
500 X=7; Y=254; LINK W
              : enable channel A single
                tone
510 X=8; Y=15; LINK W
              : set volume level
520 FOR A=0 TO 15 STEP 1
              : step through course
                values
530 X = 1; Y = A; LINK W
540 FOR B=0 TO 255 STEP 1
              : step through fine
                values
550 X=0; Y=B; LINK W
560 WAIT
              : slow sweep down
570 NEXT B
580 NEXT A
590 END
```

Listing 3. Varying tone

```
500 X=0; Y = 88; LINK W
              : set tone on channel A
510 X=7; Y=254; LINK W
              : enable channel A
520 X=8; Y=16; LINK W
              : set 'envelope' mode on
                channel A
530 X = 11; Y = 144; LINK W
              : set envelope period
                low byte
540 X=12; Y=200; LINK W
              : set envelope period
                high byte
560 X=13; Y=10; LINK W
              : set envelope pattern 10
570 END
```

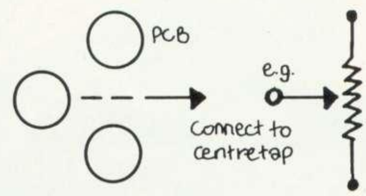
Listing 4. Gunshot

```
500   X=7 ; Y=247 ; LINK W
510   X=8 ; Y=16 ; LINK W
520   X=11 ; Y=0 ; LINK W
530   X=12 ; Y=12 ; LINK W
540   X=13 ; Y=1 ; LINK W
550   X=6 ; Y=6 ; LINK W
560   LINK #FFE3
570   GOTO 500
580   END
```

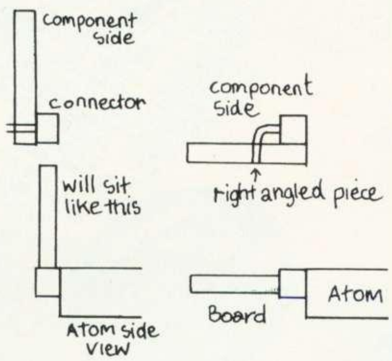
CONSTRUCTION DETAILS FOR PCB VERSION

MOUNT components on the component side of the printed circuit board, ensuring corrent orientation. Pin 1 is marked for both ICs.

Ensure the electrolytic capacitor (100 – 500uF) is oriented correctly. Mount the variable resistor (100KΩ, linear variable type).



Fit the Eurocard connector ensuring correct pin orientation (row a and b, pins 1 and 32 are marked on the board.) See pin configuration diagrams if unsure. The connector may be mounted in either of two ways:



Connect the loudspeaker by two wires to the PCB. Insert the two ICs, ensuring correct orientation. Avoid touching pins to avoid static damage.

Finally, enter program 1 and run it. Then enter listing 2, insert board and adjust the volume control.

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MMB02 BBC MODEL B + ECONET (ACORN) £ 446.00
MMB03 BBC MODEL B + ECON/DISK INT (ACORN) £ 516.00
MMB04 BBC MODEL B + DISK INTERFACE (ACORN) £ 469.00
MMB05 BBC MODEL A (ACORN) £ 299.00
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MMB17 RGB CABLE (MICRO MAN) £ 5.75
MMB18 12" GREEN MONITOR (PRINCE) £ 99.00
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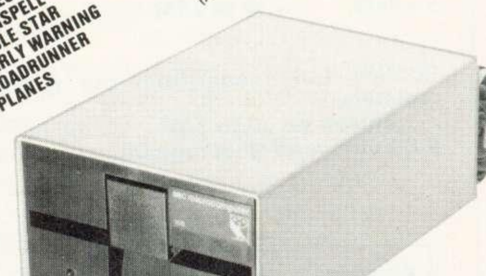


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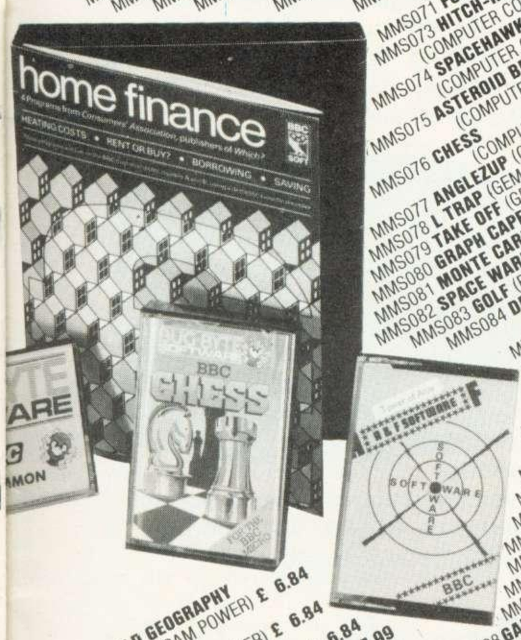
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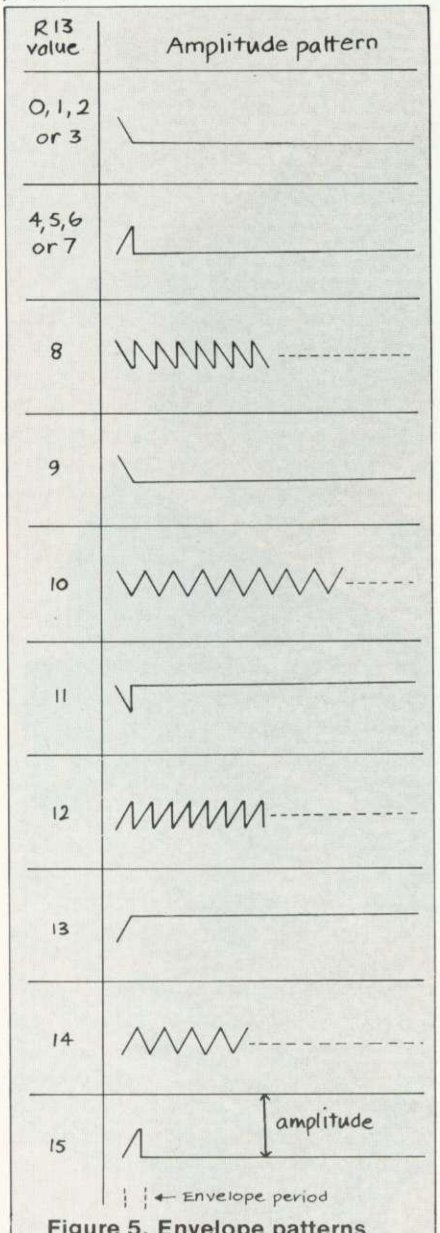


Figure 5. Envelope patterns

bit 7	port B control	1 – output	0 – input
bit 6	port A control	1 – output	0 – input
bit 5	channel C noise enable	0 – enabled	1 – disabled
bit 4	channel B noise enable	0 – enabled	1 – disabled
bit 3	channel A noise enable	" "	" "
bit 2	channel C tone	" "	" "
bit 1	channel B tone	" "	" "
bit 0	channel A tone	" "	" "

Table 1. Register 7 functions

the tones. A value of 0 produces a high pitched hiss, whereas 31 produces a low rumbling hiss. The listing below demonstrates this:

```
500  X=6; Y=15; LINK W
     : set noise level
510  X=7; Y=247; LINK W
     :  enable noise on to channel A
520  X=8; Y=15; LINK W
     :  set volume to maximum
530  END
```

Now we come to the most useful register of all, envelope control. We have seen that simple or multiple tones can be created with set volume levels. However, in the production of more complicated sounds the AY38910 offers full ADSR control of the output channels (attack, decay, sustain and release). This allows volume levels of channels to be varied in accordance to specific output patterns, eg sounds can be made to drop in volume from maximum to zero over a specific period of time. Envelope mode is enabled onto any channel by placing a volume value of 16 in the corresponding amplitude control register (set bit 4 in registers 8,9 and 10).

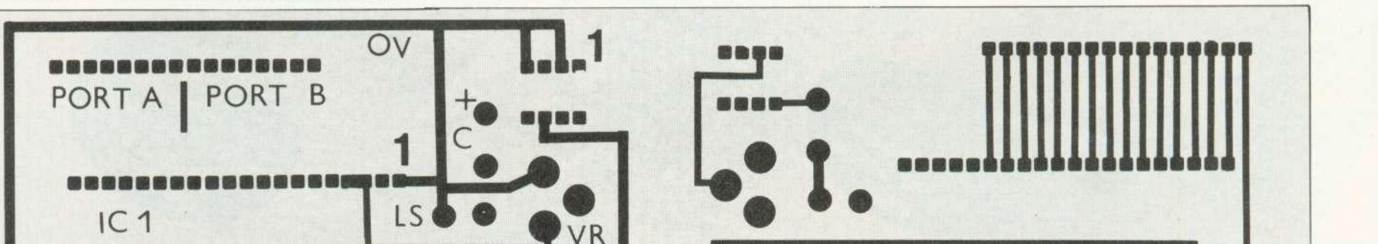
When an envelope is chosen for a channel (ie 16 has been placed in the corresponding amplitude control register setting 'envelope' mode), the output volume will vary according to the wave pattern (envelope pattern) selected. For examples, see figure 5.

The envelope period control register controls the time periods for the envelope pattern. This is a 16-bit register formed by combining the two eight-bit registers, 11 and 12. Register 11 forms the lower eight bits (fine tune) and register 12 forms the upper eight bits (coarse tune). This period varies from a few microseconds up to several seconds; ie, a low value (eg 20) will produce a time period of a few microseconds, whereas a maximum value of 65536 will produce a period of several seconds.

Before entering any data, it is advisable to write zero to every location in the AY38910. This cancels any sounds and can be done by:

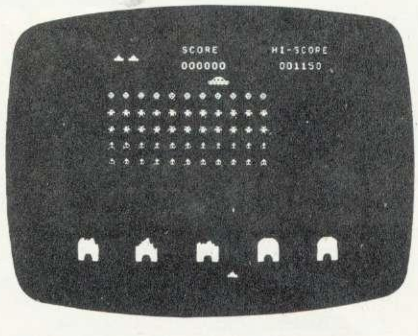
```
FOR X=0 TO 15; Y=0; LINK W;
NEXT X
```

When a sound has been programmed into the registers, it will continue until altered or reset,

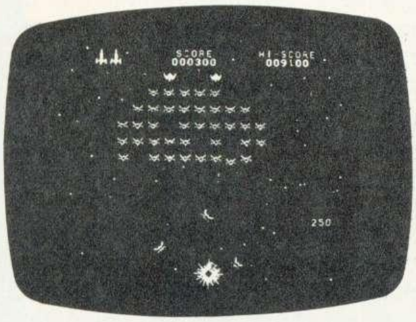


Patterns for double-sided board. Holes must be plated through

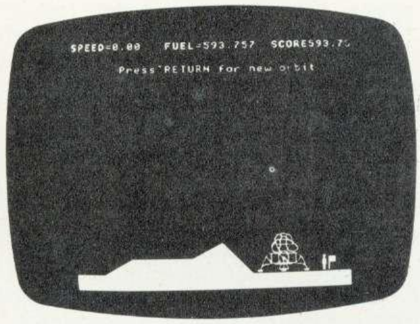
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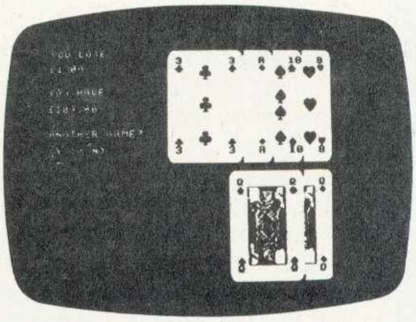
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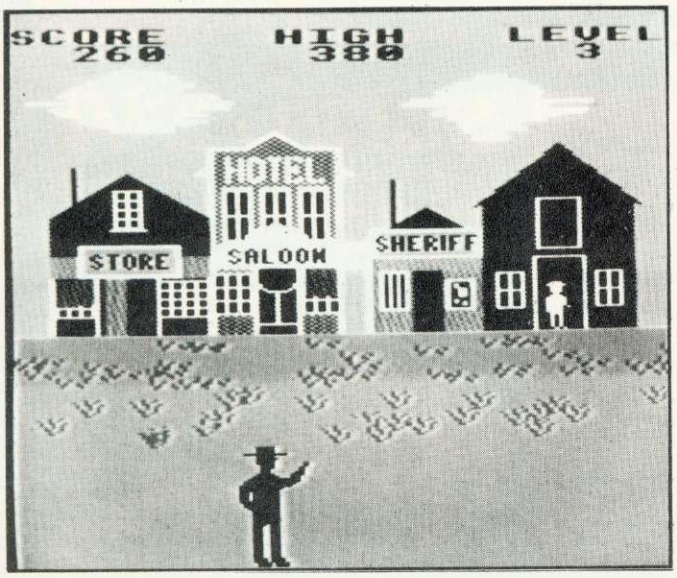
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GUNSMOKE runs on a BBC Micro model B and costs just £7.95 inclusive.

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and thus releases the Atom to continue with its program. A sound can be modified by changing the required registers. On entering a new value into any of the registers, the generator will take immediate action and create a sound relating to the new values. Before entering any of the example programs, the main program must be entered and run. Once the program has been run it can be deleted, since the machine code it creates is placed out of the way. (NB the machine code can be relocated to any desirable address since it occupies only 60 bytes).

The best way to see what sort of sounds the AY38910 is capable of is to experiment. When using the write routine, set W to the start of the write routine, X should be set to the required register number (0 to 15), and Y should contain the data to be written. Use with LINK W. With the read routine R should be set to the start, X should be set to the required register number. #80 will contain the data read.

Because the PSG is latch driven the following sequence must be performed to write to any register:

Write
1. send latch address signal.
2. send address (0 to 15).
3. send latch data signal.
4. send data bus tristate signal.

Read
1. send latch address signal.
2. send address.
3. send read data signal.
4. read data.
5. send set bus tristate signal.

Acorn User has arranged for a high-quality circuit board to be made up for use in the circuit outlined in this article. The cost of a double-sided silkscreen printed circuit, with plated through holes and component overlay is £5.38. This includes VAT and UK postage (write in for overseas prices).

Kits of parts, as well as fully built and tested boards are being prepared, prices on application.

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Once a register has been latched it will remain latched until a new register address is sent. This allows multiple read and writes to a register. Reading any register will give its present value.

To conclude, the AY38910 offers good quality sound effects at a modest price and is easily adapted to interface most small eight-bit micros. Programming simple tones and notes is child's play, but complex sounds require a little more work with up to 13 data registers. The chip can produce sounds that vary in volume as well as pitccan be made to die or increase i volume or even repeat. If any Atom enthusiasts are thinking of expanding the capabilities of their machines then the Ay38910 offers an inexpensive addition, of particular interest to games fanatics. Atom owners using Forth also have the possibility of stimulating the envious sound and envelope commands of the BBC micro.

INTERFACE BOX FOR THE BEEB

▶*page 55*

analogue input, you can hear the noise of the continuous stream of interrupts which the machine is producing. This can be useful in an educational context.

If using a printer with a parallel interface, you may decide not to use the printer port for interfacing. There is no harm in simply leaving it off the circuit since none of its lines is essential to the working of the circuit as a whole. On the other hand, since the printer port can only be configured as an output and since it has a buffer chip to give it extra driving capability, there is no harm in using the port for both purposes. However, to avoid connecting and disconnecting the sockets underneath the micro, it would be worthwhile mounting an IDC plug on the box and wiring it in parallel with the sockets, so the printer could then be plugged into the interface box. This has the added advantage that if you have a set of eight LEDs you can monitor data on the lines going to the printer – this again has obvious educational value.

Whilst on the subject of the printer port it is worth saying again that it is configured for output only since it has a 74LS244 buffer on it which is uni-directional and permanently enabled. Thus if you do try to input to the printer port you may blow up the chip. The advantage of having the buffer chip is that the drive capability of the port is thereby increased markedly over the PA port on the 6522 versatile interface adaptor from which it comes. If a given line is at logic 1 it is capable of supplying 1mA with hardly any voltage drop and can manage up to about 5mA. When it is at logic 0 it can 'sink', ie draw into the chip, something like 10mA, and I have tested it up to 25mA with no obvious ill effects. But in practice I would work on being able to supply 2mA at logic 1 and sink 10mA at logic 0.

Acorn User has arranged for a high-quality circuit board to be made up for use in the circuit outlined in this article. The cost of a double-sided printed circuit, with plated through holes and component overlay is £11.95. This includes VAT and UK postage (write in for overseas prices).

Kits of parts, as well as fully built and tested boards are being prepared, prices on application (should be about £80 for completed board).

Write to Acorn User Board Offer, Electro Technical Services, 55 Raymond Road, Hellesdon, Norwich NR6 6PN. Discounts are available on large orders. Please allow 28 days for delivery.

Next month: Applications for the interface box and some test routines if you decide to make the circuit yourself rather than buy it ready-built and tested.

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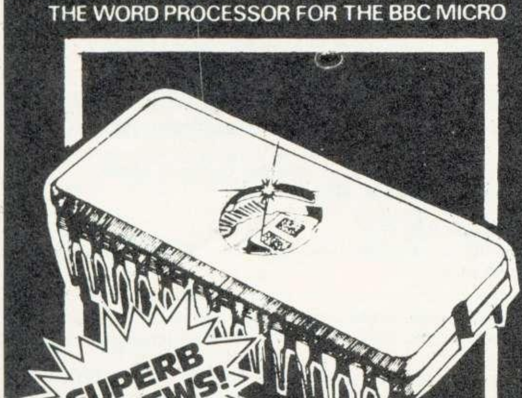
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This includes routines for high resolution screen dumps for both the EPSON and NEC printers. Will work in any graphics mode with automatic grey shading of all screen colours. The most useful feature of this program is its 'spooling' capability, this enables data such as a program listings or high res screen dumps to be automatically spooled from your disk to the printer **while** using your BBC machine for running other programs.
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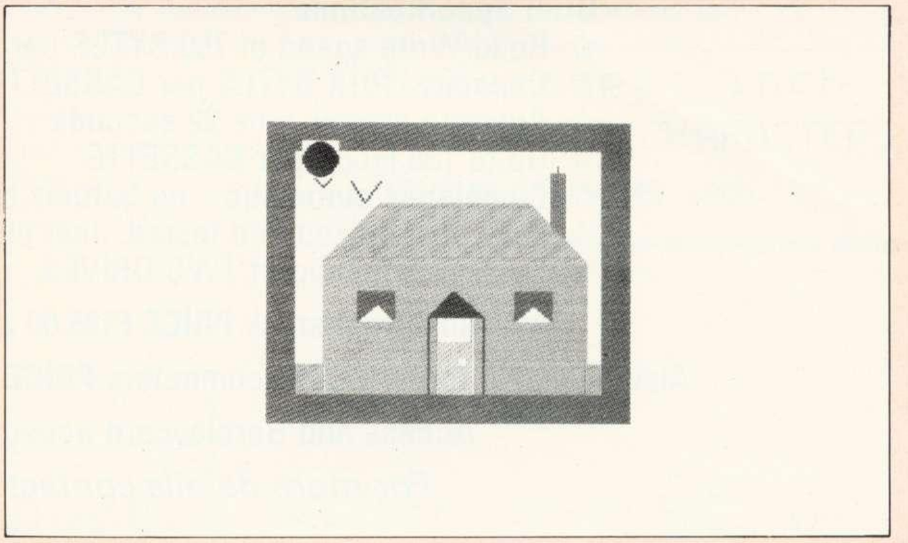
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BARCLAYCARD VISA

Typeface and manual spoil excellent graphics from fast Olivetti printer, says George Hill

ITALIAN PRINTER, GOOD FOR GRAPHICS



THE Olivetti printer is of a type not seen before in the home-computer market as it operates on the 'ink-jet' principle. The ink is not liquid, but is a compressed solid, in a small, easily replaceable glass tube. Ink is 'fired' at the paper by a spectacular electrical discharge, and the resulting black dots are directed by electrical fields. In effect it is a dot-matrix printer, and must be judged by the standard of others in its price-range *(£360)*.

The Olivetti is very compact, but its big advantage is that the dots are very small which means superb graphics printing – I doubt whether any other printer can rival the resolution. It prints 110 dots per inch in the horizontal direction, and an amazing 220 vertically. The picture of the film star's face (Marilyn Monroe or Jean Harlow?) beloved of printer adverts can be reproduced in amazing detail on a rectangle less than two and a half by two inches.

On sending a single escape code ESC CHR$(45), the image can be reversed, and another sequence ESC CHR$(47) doubles the picture size. The resolution is in fact greater than that available in any Atom or BBC graphics mode.

Graphics dumps are easy to write for the Olivetti. A minor quibble is that there are 880 dots in the horizontal direction, while most computers use multiples of 320 on this axis.

The image is defined in terms of bytes both horizontally and vertically, which means the whole picture is defined in a single escape sequence at the start of the program. The manual is as usual confusing on this point. I would explain it as follows. The sequence is: ESC G l ; m ; n ; o ESC Z

l is the number of dots skipped in the left margin.
m is the number of dots on the X axis divided by 8.
n is the number of dots on the Y axis divided by 8.
o is the spacing between rows of dots.

As usual these parameters are critical, and miscalculations cause chaos!

The printer has a good variety of printing styles (figure1), including three selectable horizontal spacings giving 80, 97 and 147 characters per line; and double width, double height, and double width-and-height in each of these spacings. Unfortunately it does not seem possible to mix single and double height characters on a line, and the linefeed is automatically doubled when printing double height. Thus it is possible to produce super-scripts, but subscripts are less successful.

Printing is fast, giving 50 full lines per minute at whatever spacing. Maximum speed is 120 characters per second, and an average during program listing of about 60.

The Olivetti has enormous potential, but (and it is a big *but*) the ship seems to have been spoiled for a ha'p'orth of tar. The character font (in ROM) produces characters on a seven by seven dot matrix. This means capital letters are printed on a notional line one dot below that on which lower case letters appear (figure 2). Thus although g, y etc, have 'true descenders', so do all capitals and numbers.

The print is thus not letter quality, and has a curious 'squashed' appearance. Changing to a nine by seven matrix would have produced such a huge improvement that the minor decrease in speed would have been well worth the sacrifice. The character set is 'international', as befits an Italian printer, with the ability to produce German, Norwegian and French characters. The 96 character font does not include 'chunky graphics' characters or italics, and characters from 128 to 255 feebly repeat those from 0 to 127.



The Olivetti JP 101 Dry Ink-Jet Printer

Also the linefeed arrangements leave something to be desired. You can select linefeeds from one line upwards, so the paper always advances at least one line whenever the printhead returns to the start of the line. This is not selectable, and you are thus debarred from overprinting.

The printer is clean in normal use, producing an unsmudged output. However, if you leave the paper stationary after a dense graphics dump (eg a 'reversed' picture), the printer leaves a faint black line on the paper where ink has been deposited from the paper guide.

Finally, to my *bête noire,* the manual. Do manufacturers deliberately set out to confuse their customers? Have they no idea their product may be bought by people with no experience? The Olivetti's 'Little Red Book' is one of the worst.

Four pages are devoted to the trivial task of using the roll holder, and feeding paper into it, while 12

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pages are wasted on technical details of the interfaces. The only important piece of information in the latter section, the settings of the DIP switches, contained a serious misprint in the numbering.

The section devoted to operating commands occupies a mere nine pages (omitting pictures). A curious convention is used throughout, with hexadecimal numbers represented by fractions! These are nowhere translated into decimal, and in some cases are omitted altogether. The only program examples concern graphics, and use LPRINT, rendering them difficult for Atom or BBC users to translate. Finally, in common with most printer manuals, there is no alphabetical index.

So, if you want to produce legible program listings and superb pictures, the Olivetti is as good as anything in its price range. However, if letters and circulars are your aim, better print quality is available from a conventional dot matrix printer for the same price.

Next month: A Basic graphics dump for the Olivetti.

```
This is printed at 10 characters per inch
(the default value) and this is at 12 CHARACTERS
per inch and NOW the little characters at 18 characters per inch

Normal
line spacing
Reduced
line spacing
This is

double spaced

using the variable option

NORMAL size
DOUBLE width
DOUBLE height
DOUBLE width and HEIGHT
Back to normal
Not underlined
Normal underlining
Double underlining
dotted underlining
```

Figure 1. Sample output (also see listings in Joe Telford's article, p27)

```
acters per inch
 is at 12 CHARACTERS
18 characters per inch
```

Figure 2. Close up of the offending type design

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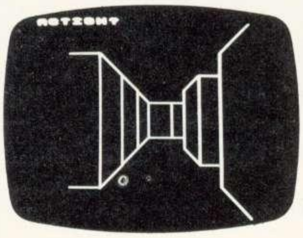
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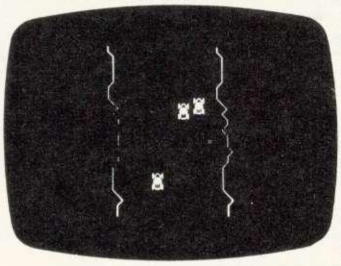
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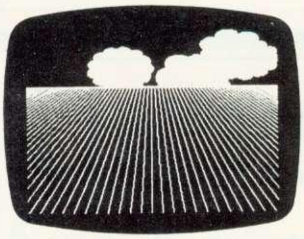
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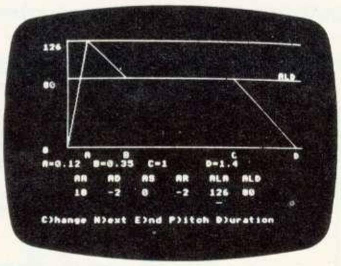
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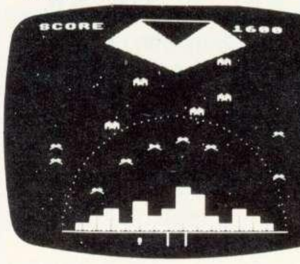
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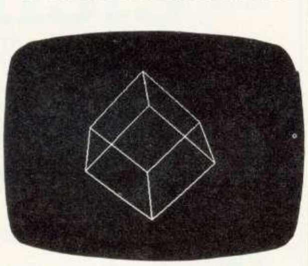
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3D ROTATION, MARCH 1983

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July Issue BEEB INVADERS and other programs—plus articles on using the Teletext mode, BBC cassette bugs fix, Software Review, using user defined keys. More on structuring in Basic. Using the User Port, and many hints and tips.

September Issue: High/Low Card Game, and Hangman Programs. Articles on Logic on the Beeb, Debugging, Moving multicoloured characters, creating new colours, Operating system 1.1. Plus Postbag, Hints and Tips, and Procedure Library.

October Issue: Program Features: Alien Attack; Calendar Generator; Union Jack; Memory Display utility. Plus articles on Beebugging; Improving Key Detection; Acorn Press Release on O.S.H.2; and Issue II Basic; The Tube and Second Processor Options; or New Series for less experienced users; and Software Reviews.

November Issue: Program Features: Racer (excellent 16K racing car game), Mini Text Editor (Mk2), Transparent Loader, Music with Memory, Harmonograph Emulator, New Character set for Modes 2 & 5; and cassette block-zero—bug retrieve. Plus articles on sound and envelope design—includes indispensable envelope editor program; Debugging Part 3, BBC Basics—Memory Maps and addressing explained; Serial Printer Port (RS423) and RGB upgrade. Plus a large number of Hints & Tips, and a guide to our past issues and their contents.

Dec/Jan Issue: Program Features: Space City (invader-type game), Breakout, Artist (Joystick painting program); Rescue (miraculously retrieves programs after bad loading or 'Bad Program' message); and Pack—a program to compact Basic programs. PLUS Disc System Review, Software reviews—including Wordwise, Book reviews, Adding Joystick interface to model A; How to access the video controller chip; and ideas for the newcomer; plus a new crop of Hints and Tips.

February Issue: *Program Features:* BEEBMAZE—Find your way through the random maze, guided by 3D views from inside the maze—an excellent game. FIVE-DICE—A Beeb implementation of YAHTZEE (R), a novel dice game. Also a listing of WINDY FIELD—a creation from Acornsoft, SPIROPLOT screen doodler, and a complete memory display program in a user key. Plus Machine Code Screen Dumps for the Epson and Seikosha Printers; articles on USING FILES, IDEAS ON ANIMATION (Including a Rotating Cube program), an Introduction to the Use of Procedures, a Survey of Books on the BBC Micro, and a Roundup of Disc System Hints. PLUS a variety of HINTS, TIPS AND INFO, including a single VDU command to perform a SIDEWAYS SCROLL. WIN A COLOUR MONITOR, WORDWISE WORD PROCESSORS AND ACORNSOFT GRAPHICS BOOKS IN OUR THIRD SOFTWARE COMPETITION.

March Issue: Program Features: Life (32K), Artillery Duel (16K/32K), Square Dance. 3D Rotation (will rotate any object). Printers for the BBC micro—Review of Epson, Seikosha, Tandy and Olivetti. What to do with the new Operating System Chip, Disc Formatter Program, and full Disc instruction set, Newcomers, article on Text and Graphics Windows. PLUS How to get a new Operating System ROM and a special deal on Wordwise (members only).

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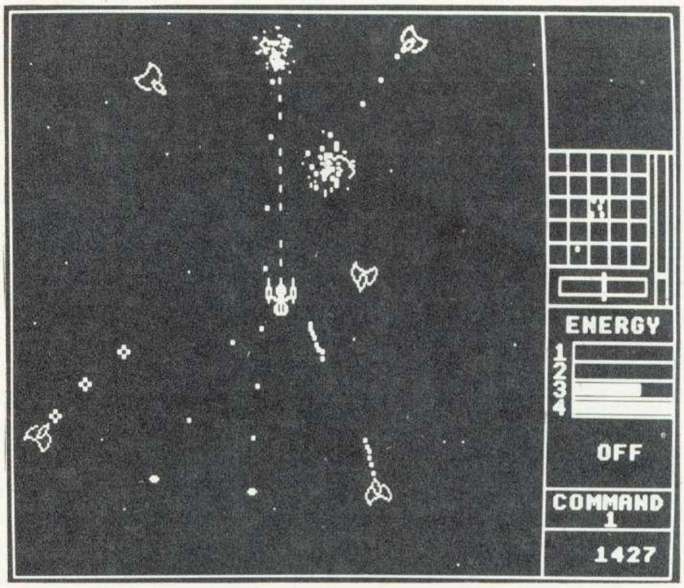
ACORNSOFT REACH DIZZY HEIGHTS

FIVE minutes on Starship Command and I was hooked – but dizzy. It's a *Star Trek* and *Asteroids* combined with keys controlling rotation, thrust, brake and fire (for starters!).

There are two strategies. You can sit tight and let the enemy ships come to you (saving energy and dizziness) or chase them, dog fight style. The dizzy spells come in because everything rotates around your ship, which stays in the centre of the screen.

Once your ship's energy has gone, it self-destructs – but there is an escape capsule and you can get another chance.

It's all in black and white, hi-res graphics on a model B. Acornsoft produce the game for £9.95. Another neat feature is a 'freeze' option, so you can stop, answer the phone, and re-start. – TQ



BASIC, MY DEAR WATSON

Elementary Basic by Henry Ledgard and Andrew Singer (272pp, Coronet, £4.95)

THIS unusual book is aimed at people who are keen on learning to write serious programs. It purports to be an unpublished Sherlock Holmes manuscript which reveals how Holmes got his hands on Babbage's Analytical Engine.

Through the eyes of Dr Watson (being his usual doltish self) the great detective uses the engine, programmed in Basic, to solve a number of criminal cases. On the way, Watson (and the reader) are shown a great deal about program structures, functions, subroutines, data files, algorithms, etc.

Holmes's main emphasis throughout is on the necessity of adopting the 'top-down' approach in designing and writing a program. In essence this method requires the programmer to design the program in a hierarchical system of different levels. At the topmost level the more general aspects of the problem are defined (probably in English rather than a computer language), and the more specific questions (such as the internal representation of data) are worked out in increasingly fine detail in Basic on the lower levels.

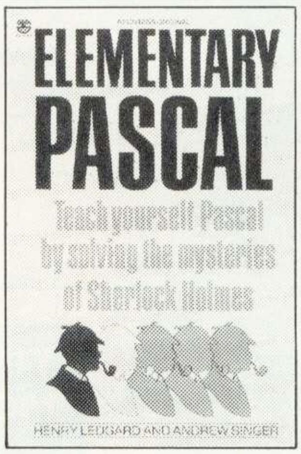
It is certainly the most rigorous approach, requiring the author to have thought through every aspect of the program before writing a single line of code.

Unfortunately, the programs are unlikely to be of much use outside the context of this book. This is not surprising when you consider that their main function is to illustrate different aspects of programming and problem-solving. The last chapter entitled 'The Final Programme', consists of a piece of software some 20 pages long, but I doubt if many readers will be prepared to type it out when the end result is only a word processor.

Against this it should be said that all the programs in the book are laid out with tremendous clarity and documentation. The Basic used conforms to ANSI (American National Standards Institute) Basic, which means only the file handling statements will need amending for the BBC micro and Atom.

The Sherlock Holmes gimmick is well-sustained both by the spoof Conan-Doyle prose style and by reproductions of Sidney Paget drawings from the *Strand* magazine. Certainly a book with a difference.

Simon Dally



'Holmes' book for Pascal uses same programs and ideas as Basic version

Covers are identical except for name of language

TURF PROGRAM WON'T BEAT THE BOOKIES

Horse Race Forecast Program, by Professor Frank George, Sporting Forecasts, £19.95

THIS program enables you to enter data about all the horses in a race and then evaluates the good bets. A word of caution to the get-rich-quick merchants, however: It doesn't claim to be infallible!

The author, according to the booklet which accompanies the program, is professor of cybernetics at Brunel University and 'an expert in all aspects of forecasting'. What his program does is to accept information about a race (so you'll have to equip yourself with a serious racing paper like *The Sporting Life* or *The Sporting Chronicle*) containing up to 40 horses. Using the paper, you feed in information on something like ten factors.

However, the program takes no account of factors which some fanciers of horse flesh may hold to be important: such as jockey, handicap, racetrack, and the going.

The chief drawback of the program (apart from its limited range of important variables) is the amount of time it takes to feed in data: a 10-horse race took me 30 minutes to evaluate, including the time taken to rummage through *Sporting Life*.

Still, afficionados of the turf tired of always backing a donkey may find this a useful companion while risking their shirts. Do not, however, think this package is a gateway to your fortune!

▶ page 32

string to contain the characters from which the user may choose. Some GPIR's include a range of such strings built into them. This version doesn't simply to save space. One suggestion is that in a setup section early in the program, define strings such as:

```
cap$="ABCDEFGHIJKLMNOPQ
     RSTUVWXYZ"
low$="abcdefghijklmnopqrstuv
     wxyz"
pun$= "!#$%&'()=-,.<>+*"
     +CHR$34
nos$= "0123456789"
```

plus any other special valid strings such as "YesNo". Then call up the GPIR by a line like

```
name$=FN_gpi(21,3,cap$+low$)
```

which would allow any name of up to 21 characters to be entered, using only letters. Initial letters would be capitalised.

In February, I explained a method of dynamically accessing procedures. I mentioned that this was rather naughty, but worked quite well. There were several problems based around this technique, but the main problem was that we had to self-modify code in one program line, and then use that line to call a procedure.

I have recently received a few letters from readers pointing out a much more elegant approach. It is always gratifying to see that readers will not only digest the written word, but will spend time improving on it.

Look at program 11. This is the coding which Acorn suggested could demonstrate an improved method of calling procedures.

The theory behind the coding is that while dynamic procedure calls are not covered under version 1 of Basic, functions are. The reason for this is that the reserved word EVAL is intended to enable the user to type, during the execution of a program, an expression which the computer can decode. The *User Guide* warns that EVAL can only evaluate mathematical expressions, for example:

```
A$ = "M*X+C"
P. EVAL(A$)
```

However, Acorn quite rightly point out that their implementation of functions is procedure-like, in that a function can have many lines, and once in a function any number of Basic commands can be executed. Finally, because a function is regarded as a mathematical expression, it can be called during execution of the EVAL statement.

The result is we write all the necessary procedures as functions, as in lines 180 to 400, then we can call them by a line like line 70, which is set up by the input line of line 60. If EVAL cannot find a function to match Q$ then the error trapping set up by line 10 ensures that we don't fall out of the program.

Of course this approach is extremely useful, but if you re-examine the self-modification technique in February's article, you will find that it can be easily modified to handle *SAVE <variable> and *LOAD <variable> commands, for Basic version 1. I hope to detail these in the near future, unless you know a better way?

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In addition to the disc pack a second processor is supplied. This is a Z-80A with its own 64K RAM card, communicating with the 6502A in the BBC computer through the 'Tube'. Typically the speed of execution of programs under the twin-processor system is increased by up to 50% compared with a conventional single-processor computer.

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TORCH CH240/10 — As above but with a 10 MB hard disc drive.
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Simon Dally offers £60-worth of software and examines a difficult issue

SOFTWARE PIRATES SET FOR THE BIG TIME

How many microcomputer owners can put their hands on their hearts and claim that they have bought all the commercially produced software in their library? The answer is precious few. And yet the vast majority of micro-enthusiasts are wholly law-abiding citizens who would be appalled to hear themselves described as thieves. The grossest culprits might concede *sotto voce* that they occasionally indulge in a little 'piracy' – an agreeable, romantic and swashbuckling-sounding word – but to suggest that by breaching someone else's copyright they are indulging in theft – well!

Evidence shows that illicit copying is virtually universal. A recent analysis of the owners of the popular Acornsoft game *Snapper* concluded that less than one in fifty had purchased their copy of the program. User groups are particularly guilty here. Whenever micro-owners congregate programs are swapped to and fro like cigarette cards. All this may seem fairly innocent and friendly. After all, the pooling of knowledge and the passing on of hints and tips is the fuel which powers the engine that keeps our hobby moving. But from the point of view of the software authors and distributors these trivial little transactions, multiplied by the thousand, add up to a massive loss of revenue. One software writer friend of mine has lost count of the number of times he has been offered an expensive accounting package at user group meetings. The would-be traders have no idea that he himself wrote the program!

This at least is the conventional view of software piracy, that tens of thousands of pounds are being taken from the mouths of the starving legitimate dealers because of widespread theft. But is this view necessarily correct?

One of the more disturbing features of the software market worldwide is the extent to which rubbish has become the norm rather than the exception. This is hardly surprising when to set yourself up as a software supplier your investment is limited to buying a micro and some advertising space in magazines. It is amazing how trusting people are in sending off comparatively large sums of money to advertisers they've never heard of for products they haven't seen and which all too frequently do not live up to their description. Most of us learn this lesson fairly quickly: one of the first programs I bought for my first micro was an 'expert' chess program which not only proved to be wholly ignorant of the *en passant* rule but was also inordinately fond of illegally castling through check!

Moreover, the attitude of many hardware suppliers has not helped. Some dealers chuck in a load of (pirated) software in order to clinch a sale; others try feebly to cash in on an area they don't know much about. Despite the fact that, with a few notable exceptions, Tandy software is notably inferior to other TRS 80 software (especially its disk operating systems), Tandy resolutely refuses to acknowledge the existence of anything other than its own programs. Even more deplorable was the behaviour of Commodore, who market the Vic and the Pet. They ran an advertising campaign claiming that Commodore-approved software was in some way 'good' for your machine. It later transpired that all that was necessary to obtain the 'officially approved' label was to pay Commodore some money to advertise your products.

January's problem proved a mite difficult for many of you (no doubt you were too busy trying to locate the Beale treasure). There were 26 correct entries. The first message (a substitution code) read: *to all substations new signals section chief is a right XXXX he says we are lazy with security and make too many miftaks eeee mistakes new cipher replaces existing procedure and starts twelve hundred hours tomorrow based on a famous poem every day I hate poetry.*

The second message was a book cipher based on Gray's *Elegy* ('The curfew tolls the knell of parting day . . .'). It read: *to all substations I hope this took you as long to decipher as it took me to encode the problem is how much wood could a woodchuck chuck if a woodchuck could chuck wood.*

The winner, to whom £50 worth of Acornsoft packages have been sent, was M. Booth of Morecambe, Lancs.

Against this dismal background, with the bad swamping the good and with many consumers feeling 'ripped off', you have only to place the normal human desire to get something for nothing and you have all the ingredients for a flourishing pirate trade. And the problem is that when pirates flourish good software gets ripped off even more frequently than the bad, sloppy stuff flung out to make its slapdash creator a few bob.

Considerable ingenuity and expertise have gone into the business of software protection in recent years: the most commonly-used methods are tapes which run automatically upon loading and cannot be listed, and diskettes formatted in non-standard ways. There is a growing trend to produce expensive software on EPROMs (erasable programmable ROMs) or to insist on 'dongles' being resident in the system (a dongle is a small piece of hardware marketed with the software which has to be plugged into something like the cassette interface before the program will work). There is little evidence that any of these methods adds significantly to the protection. No cassette program in the world is immune from straightforward reel-to-reel copying – on decent equipment the quality of the backup will be only marginally inferior to the original. People openly market tapes and discs

For the best hardware, the best software.

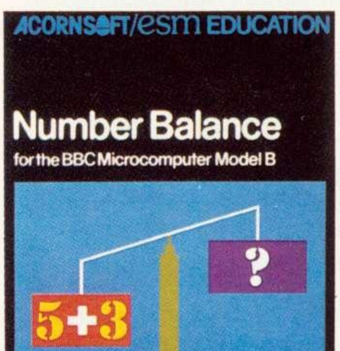
The BBC Microcomputer system is generally regarded to be the best micro in its price range you can lay your hands on. So, if you're thinking of buying one or already own one, you'll want to know about the software that's been specially designed for it.

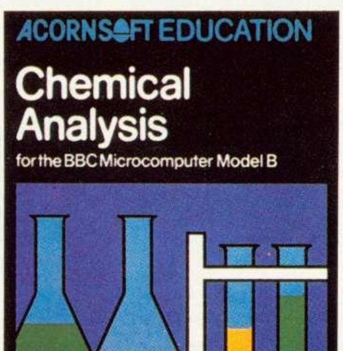
Not surprisingly, it's made by Acornsoft, the software division of Acorn Computers Ltd., who designed and built the BBC Microcomputer. So naturally you can expect the highest quality software with the built-in ingenuity to fully exploit the BBC Micro's potential.

<u>Further education for everyone.</u>

Number Balance (price £11.90) contains two programs on cassette for practising simple mathematical operations from numbers 1 to 20. The object of the exercise is to make a balance level by inputting the correct missing number into one side of a simple equation. Incorrect answers will tilt the balance in the appropriate direction; after three incorrect attempts the program responds with the correct answer.

Chemical Analysis (price £13.80) contains three Chemistry programs on cassette and a booklet. 'Elements' presents a series of mystery elements which the student is asked to identify. 'Inorganic' presents a series of inorganic substances to be

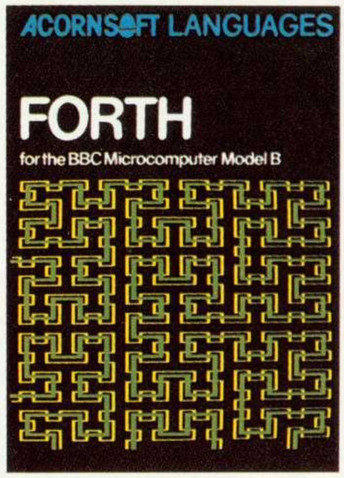


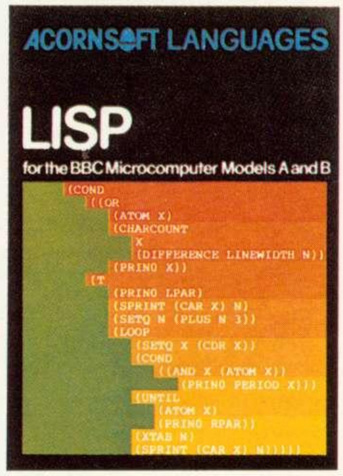


identified by performing tests selected from a menu of standard tests. 'Organic' is a program dealing with organic compounds.

<u>Learn more languages.</u>

LISP (price £24.35) is the fundamental language of artificial intelligence research.





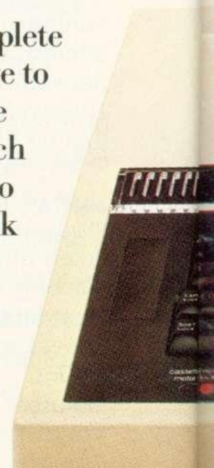
It is easy to learn, and is widely used for writing substantial and sophisticated programs, with practical applications including design of education systems and medical research.

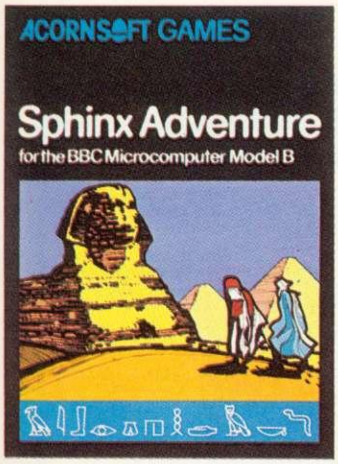
It comes complete with a book that introduces you to programming in LISP, as well as some fascinating applications.

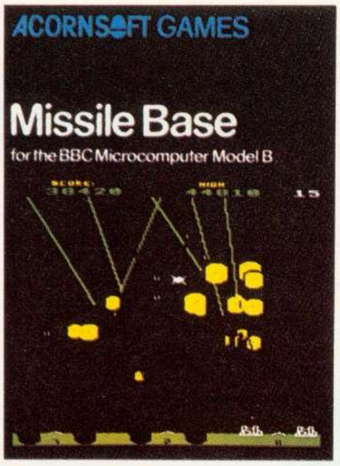
FORTH (price £24.35) is a complete implementation of the FORTH language to the 1979 standard specification for the BBC Microcomputer Model B. This much acclaimed programming language is also accompanied by a specially written book explaining all you need to know.

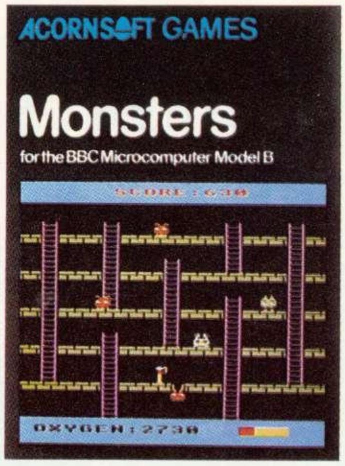
<u>Mind-boggling games.</u>

Sphinx Adventure (price £9.95) is a full-sized classic adventure game in which you move through caves, fight with trolls, collect treasure and finally make your way to the sphinx









to collect your reward.

Missile Base (price £9.95) sees you as Moon Base Commander, and you must ward off the salvos of deadly neutron missiles falling from space onto your base. As the game progresses, intelligent missiles arrive on the scene. They must be destroyed with cunning. Comes complete with satellites and planes and includes a table of high scores.

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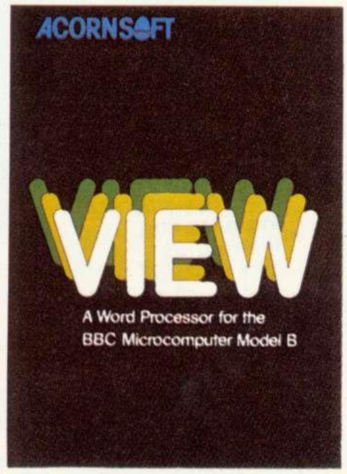
VIEW (price £59.80) is a program that enables your machine, together with a printer, to operate as a fully operational word processor. For convenience the program is in ROM so that it can become a permanent feature of your machine. (It can easily be fitted by your local dealer.) You'll find out more by going to your dealer or by sending for the free catalogue.



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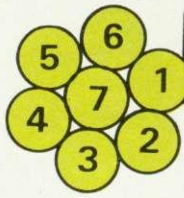
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ACORNSOFT



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£60 worth of software to be won

A) This is for under-13-year-olds only. Please give your school and class with your answer. A prime number is a whole number exactly divisible only by itself and 1. 1, 2, 3, 5, 7, 11 are all primes. For many years it was thought that both the numbers 1,757,051 and 222,221 were prime numbers. Why aren't they?

B) Use the accompanying diagram to form seven-digit numbers by starting at any number and moving to any adjacent number but using each digit once only. How many numbers can be formed which are exactly divisible by 11?

Answers on a postcard please to May Competition, *Acorn User*, 53 Bedford Square, LONDON WC1B 3DZ before 1 June 1983. The first three winners picked will win £20 of Acornsoft packages. Please state which machine you have.

which are claimed to copy any other tape or disk (the advertising usually claims that it is to enable you to back up your valuable personal software but who are they trying to kid?) Dongles can be circumvented by amending the part of the program which checks to see if they're in residence. And for around £10 a reasonably competent pirate can build himself an EPROM copying machine. Ironically, an advanced and user-friendly machine like the Beeb makes a pirate's life even easier. It's fairly simple to dump virtually any block of memory on to disc and thence into an EPROM. The one area on the Beeb which looks as if it may increase protection is the use of plug-in cartridges.

All this means that the job of copyright – and hence revenue – protection for software authors is extremely difficult. However, there is one line which can be tried in addition to electronic protection and that is to market, along with the program, other items which are essential to the running of the program. The most obvious example is a bulky manual. OK, photocopying machines aren't difficult to find but they do make the pirate's job more expensive and time consuming. Some American companies sell their manuals independently of the program at, say, half price, presumably reasoning that if you've pirated their program half a loaf is better than no bread from their point of view. Others refuse to sell manuals without proof of purchase of the program.

Best of all would be a plastic membrane which can be attached to the VDU, without which the program would make little sense – but this clearly poses practical difficulties with machines like the Beeb which are not sold with a standard size VDU included.

'Wholesale piracy for profit may become professional and ruthless'

Until recently the problem of piracy has been more or less confined to individual users trading 'swops'. There are signs however that a far more serious problem is looming. As the microcomputer boom moves from the cottage industry stakes into big business (one industry forecast believes that by the middle of next year about 10 per cent of UK households will have a home computer), it appears likely that wholesale piracy for profit will become professional and ruthless. A recent case occurred of a dealer in the home counties selling a word-processing program for the Beeb which he bought from a man who had walked into his shop with a packet of EPROMS and demonstrated it. It later emerged that this person had merely copied it from another commercially available package and the dealer had to pay out £2000 compensation to the aggrieved copyright owner. How frequently this sort of thing is occurring is anyone's guess, but it is certain to increase in the future.

The video-cassette and music industries have been brought virtually to their knees by pirates in recent years and it is beginning to look depressingly as if computer software will follow the same course. The problems – the ease of electronic copying, the pitiful legal penalties which the criminals face, and the indifference of the consumers who merely want a cheap or free deal – are easy to identify. The solutions, alas, are going to be much more difficult to find.

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Baffled by the manual? George Hill explains how to get your printer going

PRINTING FROM A TO Z.........

```
10 REM send A to Z to screen via PRINT CHR$
20 FOR I = 65 TO 90
30 PRINT CHR$I
40 NEXT I
```

Program 1. Letters on separate line

```
10 REM send A to Z to screen via VDU
20 FOR I = 65 TO 90
30 VDU I
40 NEXT I
```

Program 2. Letters on same line

This article is aimed at those with a BBC model B and a printer. I shall expand on the somewhat sketchy (and in some respects misleading) information in the *User Guide*, to enable you to start using the facilities of your printer to the full.

After unpacking your printer and connecting up, establish that it works by carrying out the 'self-test' procedure (available on almost all printers). Instructions for setting it in motion will be in the printer manual. Normally, it involves switching the printer on while holding down one or more of the control buttons. The printer will print all of its characters and maybe some other information.

You have now established that the printer works and provided that the computer does as well, you can connect the two and try them out.

First you must make a crucial check. Is your printer connected in serial or parallel? If it plugs into the printer socket under the computer, then you have a parallel printer, if it plugs into the RS423 socket at the back of the computer, you have a serial system.

The parallel printer socket is selected by default (if you do nothing about it, then all output designated for the printer will be sent to the printer socket under the computer). To be certain you can type *FX5,1 which directs output to this socket. This procedure is often referred to as calling the printer.

For a serial printer there is a two-stage calling process. Type *FX5,2 to select the RS423 socket. Then type *FX8,n to select the baud rate. This must be matched between computer and printer to stop the printer from misunderstanding signals from the computer. The printer baud rate will be selected in the depths of the printer by dip switches or jumpers. Your manual will tell you how to set them. If possible select 9600 bits per second and use *FX8,7. Otherwise, select the highest rate possible at the printer, and choose n to match the computer's rate to the printer's.

In the following I have used the symbol <RETURN> to mean 'press the return key', and CTRL B means 'hold down the control key (marked CTRL), strike the capital B once and then release the CTRL key'.

To test your printer initially, try the following procedure. Type

CTRL B <RETURN>
PRINT"THIS IS TO TEST THE PRINTER"<RETURN>

Both screen and printer should respond

>PRINT"THIS IS TO TEST THE PRINTER"
THIS IS TO TEST THE PRINTER

The screen will also show > at the beginning of the next line, but the printer is often one step behind, and it may not print the > until it receives the next instruction to print. Next type <RETURN> CTRL C and the printer will print the missing >.

If your printer overprinted everything on one line, then type *FX6,0 and try again. This instruction will be explained later. Now type

PRINT"PRINTER OFF ?"
<RETURN>

The printer should remain silent, but the screen shows

PRINTER OFF ?
>

Your computer transfers all its information about letters and other characters around its circuits as numbers. These numbers must be between 0 and 255, as they are a single byte (see April's article). The code system used is the ASCII code (American Standard Code for Information Interchange). In this system the letters A to Z are represented by the numbers 65 to 90 and the other letters and symbols by other numbers between 32 and 127. These codes can be sent to the screen in two different ways. Programs 1 and 2 illustrate the methods. One involves the use of PRINT CHR$n where n is the ASCII code, but the other quicker and more convenient method uses VDU drivers. I advise all BBC users to familiarise themselves with the VDU codes as they are extremely useful and powerful.

You will notice a difference in the outputs from the two programs. Program 1 prints the letters on separate lines, program 2 prints them all on the same line. Each PRINT statement implies a <RETURN> at its end, unless it is followed by a semi-colon. To make the output of the programs identical you change line 30 in program 1 to PRINT CHR$I; and PRINT CHR$n; is identical to VDUn.

If you now run either program (program 1 in the modified form) with the printer enabled by CTRL B, output will also appear on the printer. But some printers have a buffer (a memory of their own) and the buffer stores items to print until it receives an instruction to empty, or it is full. So to get output at the printer type

RUN CTRL B <RETURN>
<RETURN> CTRL C

and the printer should print A to Z, and a > (the BBC's prompt), all on the same line.

The CTRL key simply subtracts 64 from the ASCII code of any key pressed simultaneously. CTRL B is actually sending (66 – 64) which is 2, to the central processor, which interprets this as a signal to enable the printer. Similarly CTRL C sends 67–64, ie 3, which disables the printer. We can send these codes within a program, using VDU2 and VDU3. Programs 3 and 4 will enable the printer, send A to Z to it and the screen, and disable the printer. Note the use of an extra PRINT or VDU13 (<RETURN>) to ensure that the printer empties its buffer.

```
10 REM send A to Z to printer and screen
20 REM enable printer
30 PRINT CHR$2;
40 FOR I=65 TO 90
50 PRINT CHR$I;
60 NEXT I
70 REM empty print buffer if necessary
80 PRINT
90 REM disable printer
100 PRINT CHR$3
```

Program 3.
Sends 'A to Z' to printer

```
OR 30 VDU2
OR 50 VDU I
OR 80 VDU 13
OR 100 VDU 3
```

Program 4.
Change lines in program 3

Characters which are genuine in the sense of printing a character on the screen, start at an ASCII value of 32 – the space character. Codes 0 to 31 have specific effects which are detailed in pages 378 to 388 in the *User Guide*. All are important and useful, but some are of crucial importance to the printer user.

VDU2 enables the printer, and VDU3 disables it. I have used the same terms as in the *User Guide*, as these describe the action better than any combination of on and off, which might cause confusion with on/off line, and power on/off.

Three other codes which affect the printer in simple ways are VDU10, VDU12, and VDU13. These are linefeed, formfeed and carriage return respectively. Most printers respond to all three of these codes, but some (for instance the Amber) only accept 13 and ignore the others. The formfeed character clears the screen if sent there (it is the equivalent of CLS) and the printer accepts it as an instruction to advance the paper to the next top of form (top of a page). It is set when the printer is switched on, and can be reset by switching the printer mains switch off, moving the paper by hand to the top of a page (normally the perforation on fanfold paper) and switching back on again. Some printers have a set top of form button which you can use to avoid having to switch on and off.

If you type CTRL B CTRL L (ie enable printer, send [76–64]) the printer should now move the paper up to the next perforation, and the screen should blank. If the paper moves up to a position other than the one you wanted, you need to reset the dip switches which control formlength on the printer, to match the length of your paper. Details of how to do this will be found in the printer manual.

Now to the linefeed problem. The BBC micro is set to suppress linefeeds in its printer output. This means that when the computer reaches the end of a line it sends code 13 and code 10 to the screen, causing the cursor to go back to the beginning of the line and go down one line. Only code 13 is sent to the printer. This may be compensated for in two different ways. Either the printer may generate its own linefeed on the receipt of each return, or it may be made to send both codes to the printer. The reason for this flexibility is that printers respond in different ways to codes 10 and 13. There are four main possibilities.

- Literal - 13 returns the printhead to the beginning of the line, and 10 advances the paper by one line, and returns the printhead.
- Auto-linefeed, with code 10 ignored – on receipt of code 13 the printer returns the printhead to the beginning of the line and advances the paper by one line, but ignores code 10.
- Auto-linefeed with all linefeeds acted on – on receipt of code 10 or code 13 the printhead returns and the paper is advanced one line.
- Intelligent auto-linefeed – in this method the action is as for auto-linefeed in that both codes 10 and 13 are accepted as instructions to empty the print buffer and perform the appropriate action. When codes 13 and 10 are received together (as at the end of a line) it only acts on one of them.

You may be able to select some of these options by dip switches at the printer. In many ways the first is the best option, as it allows you to overprint lines. If you had the problem of overprinting at the start of this test procedure and had to type *FX6,0 then you probably have this option.

The *FX6 command is used to suppress any one character in the output to the printer. On switching on the BBC micro it defaults to *FX6,10. That means that the linefeed character is suppressed. By typing *FX6,0 you have suppressed character 0 (which does nothing anyway) and reactivated character 10. Note that only one character can be suppressed at a time. Try typing

*FX6,65 <RETURN>
PRINT"AARDVARK" CTRL B <RETURN>
<RETURN> CTRL C

The printer should respond RDVRK while the screen shows AARDVARK. You have suppressed A (code 65) in the printer output.

To test which of the four options your printer has in operation, try the following test procedure. Type

*FX6,10 <RETURN>
CTRL B <RETURN>
<RETURN> <RETURN> <RETURN>
CTRL J CTRL J CTRL J
*FX6,0 <RETURN>
CTRL J CTRL J CTRL J
<RETURN> <RETURN> <RETURN>
CTRL C <RETURN>

If at step 3 your printer printed three > signs at the start of the

same line, without the paper moving, you have the first option. Step 4 should produce no effect (linefeeds are disabled and CTRL J is code 10).

If at step 6 the paper did not advance then you have the second option.

If after step 7 your printer printed the > signs with a blank line between them then you have the third option otherwise you have the last option.

If this test shows that you have the second or third then you should leave the default setting of *FX6,10 in operation. If you have the first then you must type *FX6,0 before using the printer. If you have the last then it does not matter whether you use *FX6,0 or *FX6,10. If you want to use CTRL J or VDU10 to advance the paper then use *FX6,0.

Note that any second option printers (like the Amber) will not respond to any code 10 calls in the next program, and these will have to be replaced by code 13.

There are two ways of sending control characters (those with codes between 0 and 31) to printer and screen. From the keyboard (CTRL and a letter) and in a program (VDU followed by a number). Program 5 illustrates the latter process.

It is often important to be able to send characters to the printer only and not to the screen. The code which allows this is code 1. This code has a slightly different action in OS 0.1 from that in OS 1.0 causing me considerable problems! It is intended to work by enabling the printer, sending code 1 and the code for the character. This last will be ignored by the screen but sent to the printer. Program 6 illustrates this and sends A to Z to the printer only.

Owners of machines with OS 0.1 may have found that they can use code 1 followed by a character, without enabling the printer first, eg typing VDU1,12 <RETURN> sends a formfeed to the printer, but does not affect the screen. To have the same effect in OS 1.0 you must type VDU2,1,12,3 <RETURN> (enable the printer), send formfeed to printer only, and disable printer. The same sequence in CTRL characters is obtained by holding down the CTRL key and typing BALC, then releasing the CTRL key.

```
10 REM send 3 linefeeds to the printer, print message,
20 REM and advance to top of form.
30 *FX6,0
40 VDU2,10,10,10
50 PRINT"TEST PROGRAM"
60 VDU12,3
```

Program 5. Sending control characters

```
10 REM send A to Z to the printer only
20 REM enable printer and send A to Z
30 VDU2
40 FOR I=65 TO 90
50 VDU1,I
60 NEXT I
70 REM send linefeed and disable printer
80 VDU1,10,3
```

Program 6. Sends 'A to Z' to printer only

Acorn refer to this change as correcting a bug in OS 0.1, but it is a pity that this particular bug has been altered.

Furthermore, the *User Guide*, in its printer section refers to *FX3,n as the preferred method of directing output to the printer only. *FX3 does not exist in OS 0.1, so most people will merely get 'Bad Command' messages from any attempt to use it. There is, anyway, a serious fault in this mechanism, which is not apparently being corrected even in OS 1.2. The command which should send output to the parallel printer only (*FX3,2) simply does not work. The BBC micro therefore remains without an LPRINT equivalent, except for the use of VDU1 (which is not mentioned in the *User Guide* printer section!). For those with OS 1.0, *FX3,10 can be used to disable the screen, and *FX3,0 to re-enable it, giving a limited LPRINT facility, but codes 1, 2 and 3 still have to be sent via VDU1,n as they are intercepted by the CPU and interpreted as commands to redirect output.

Several people have written in to ask how to translate the programs given in printer manuals into BBC Basic. Most Basic's have the LPRINT command which directs output to the printer only. Lacking a satisfactory equivalent, we have to use VDU 1 to get over this problem. In normal use it probably does not matter if output destined for the printer also goes to the screen, and so the sequence

```
VDU2
PRINT"Anything"
VDU3
```

produces the desired effect.

We can avoid the total disappearance of wanted material by judicious use of the commands governing graphics and text windows, and scrolling only the text area. This involves the use of VDU 4,5,24 and 28 which you should explore but lie outside the scope of this article.

A more pressing problem is how to send escape sequences and control characters to the printer to get it to alter its style or go into graphics mode. I offer, as examples of this process, translations of two sequences detailed in the EPSON MX80 type 3 manual, but the principles are the same for all printers if the examples are given in terms of LPRINT.

To control line-spacing you use a sequence given as ESC A + n (note that the + sign is misleading and irrelevant), which is translated at the foot of the page as LPRINT CHR$(27);CHR$(65);CHR$(n) where n is the amount of line-spacing required in multiples of 1/72 of an inch. Normal line-spacing is 1/6 inch (12/72 inch). To double-space, therefore, we must increase the line-spacing to 24/72 inch. The sequence for this is ESC A 24. The codes to be sent then are 27 (ESC) 65 (A) 24.

We must not send the 27 or 24 anywhere but the printer, as 27 causes the computer to carry out its escape routine, and 24 makes it attempt to define a grahics window. It is also important to realise that the escape key is not used in escape sequences.

The command needed is VDU2,1,27,1,65,1,24,3 <RETURN>, ie enable printer, send ESC A 24 to

printer only, disable printer. The above sequence can be typed in direct from the keyboard, or used in a program. The <RETURN> is of course redundant in a program, and it is only necessary to use VDU2 and 3 once each at the start and end of the program. Program 7 illustrates this, and also the use of the ' character to generate returns.

Note that on the type 1 printer additional commands are necessary to implement these changes. Some converted type 2's may also need the additions. At lines 50 and 80 append 1,27,1,50 (ie ESC"2") to the end of the escape sequences, if program 7 fails to work.

The next program translates one of EPSON's bit image printing test programs, to test the dual density mode of the printer. The program is shown in program 8 as it appears in the manual, then translated into BBC Basic, using hexadecimal numbers, and finally using decimal numbers.

Finally, several enquiries have arisen about the use of the printer tab function. Printers do not respond to the PRINT TAB(x,y) format. It is necessary to set up a tabulation program for the printer, using the sequences described in the printer user manual. Program 9 illustrates how to do this for the Olivetti ink-jet printer, but the principles can be followed for any printer which has this facility. Set up the tab stops (ie the points along each line at which you want columns of printing to start), and thereafter the printer will advance to the next tab stop on receipt of each code 9.

In the next article in this series, I hope to introduce the principles of printing pictures, to enable readers to write their own graphics dumps.

```
10 REM linefeed alteration for EPSON MX 80/FT type 2 printer
20 VDU2
30 PRINT"These three"'"lines should be"'"singly spaced"
40 REM alter linefeed
50 VDU1,27,1,65,1,24
60 PRINT"but these three"'"should be"'"double spaced"
70 REM restore linefeed
80 VDU1,27,1,65,1,12
90 VDU3
```

Program 7. Illustrates line spacing

LINE NUMBER	EPSON PROGRAM	BBC(hex)	BBC(decimal)
150	REM bit image printing (dual density)	REM ditto	REM ditto
155		VDU2	VDU2
160	LPRINT CHR$(&H1B);"L"; CHR$(&H50);CHR$(&H0)	VDU1,&1B,1,&4C, 1,&50,1,&0	VDU1,27,1,76, 1,80,1,0
170	FOR N=1 TO 50	FOR N=1 TO 50	FOR N = 1 TO 50
180	LPRINT CHR$(&HFF);	VDU1,&FF	VDU1,255
190	NEXT	NEXT	NEXT
200	LPRINT CHR$(&HA)	VDU1,&A	VDU1,10
210	GOTO 160	GOTO 160	GOTO 160

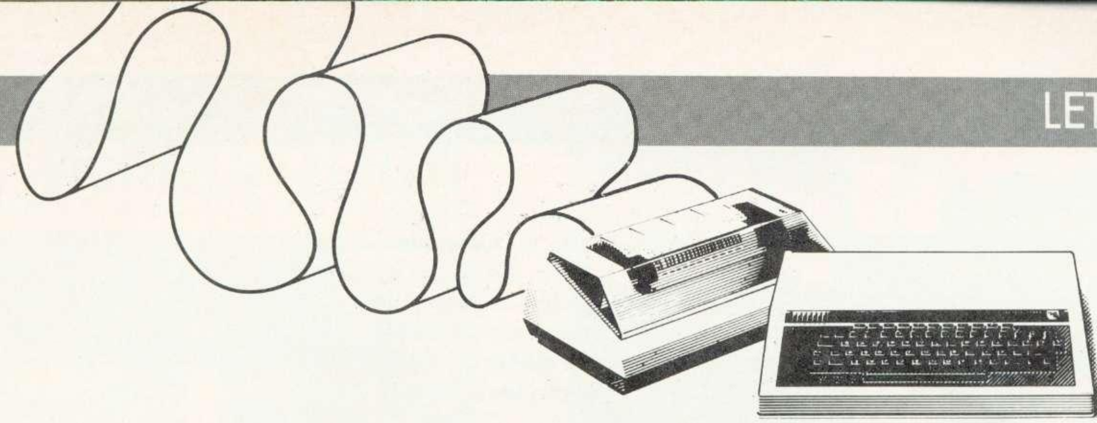
Program 8. Epson test translated

```
10 REM LETTER
20 REM TAB is set by the sequence
ESC P 80;15;60 ESC Z
30 REM Where line length is 80, and
the TAB stops are at 15 and 60
40 REM enable printer
50 VDU2
60 REM send TAB program via VDU 1
70 VDU 1,27,1,80,1,56,1,48,1,59,1,
49,1,53,1,59,1,54,1,48,1,27,1,90
80 REM new page
```

Program 9. Olivetti TAB function

```
90 VDU12
100 REM space at top of page
110 VDU13,13,13,13
120 PRINT CHR$9;CHR$9;"10 Small Street
130 PRINT CHR$9;CHR$9;"  Small Town"
140 PRINT CHR$9;CHR$9;"      Mirkshire"
150 VDU13,13,13,13
160 PRINT"Dear customer,"
170 PRINT CHR$9;"Thank you for your valued advice."
180 VDU 13
190 PRINT CHR$9;"The manager regrets the sad loss of
your budgerigar, and the consequent damage to the
vaccuum cleaner."
200 VDU13
210 PRINT CHR$9;"He hopes that the enclosed will
enable you to assuage your grief in some
appropriate way."
220 VDU 13,13
230 PRINT CHR$9;"Yours faithfully,"
240 VDU 13,13,13,13
250 PRINT CHR$9;"A.SMARM"
260 REM disable printer
270 VDU3
```

Program 9 continued



PROSE WHERE PROSE IS DUE

Sir, As a piece of journalistic literature one can hardly fault *Acorn User*. However, don't you think that users of the BBC micro want more than prose to read? After all, how many of us can correctly construct a program from a given set of criteria?

Take your competition page. Would it not be more useful and constructive if you were to use this page to show a complete analysis of your solution to the problem, with detailed comments as to how and why you did it that way?

So, please, become the first computer journal to help the programmers/ analysts of the future.

Ian Crawford
Banbury

We have taken your constructive suggestion to heart – so watch the competition pages for further developments. In the meantime you might be interested to know that we will shortly be starting a series on programming techniques.

It should be said that what you described as 'prose' has proved popular with many readers.

DIA VIA CIRENCESTER

Sir, In the March issue of *Acorn User* the information regarding the distribution of the DAI personal computer is incorrect.

Data Applications of Cirencester (tel: 0268 61828) have taken over distribution of the DAI personal computer in the UK.

Lisa Reuben
for Data Applications



TELETEL PRESTEXT?

Sir, What is the difference between a Teletext receiver and a Prestel receiver?

S. Smith
Birmingham

Teletext is a set of information pages transmitted with TV signals, and decoded by a special circuitry in your television or by a special BBC micro adaptor. The BBC TV service is called Ceefax, and ITV's is Oracle. The information is free and Ceefax is also transmitting software which can be loaded into the BBC micro and run, using the Teletext adaptor. There is also a computer newsletter called REM on Ceefax page 700.

Prestel is a much bigger system which uses the telephone network and is two-way (ie you can send information as well as receiving it). For Prestel you need to be connected to a British Telecom line, either directly or via an acoustic coupler (sometimes called a modem). Some pages are free, but most have to be paid for. A new additon to Prestel is Micronet, for computer users (see April's Acorn User). Prestel and Micronet are paid for by subscription, and are protected by a set of access codes.

The two receivers you mention are specific to one system or the other, as they use fundamentally different principles. Teletext adapters are already in production, while Prestel receivers will not be available for several months.

RE-CALL STATEMENT

Sir, There is one error in Shaw and Ferguson's review of my book (*Assembly Language Programming on the BBC Micro*, Macmillan) (*Acorn User*, March) which I hope you will allow me to correct.

The review states that 'one omission is a full treatment of the Beeb's powerful CALL statement'. This is not so. Chapter 10, pages 180–186, contains a full discussion with applications to integer and string sorting.

Ian Birnbaum
Cambs

CANARY TWEETERS

Sir,
Would you publish a note in *Acorn User* stating that some members of our club are interested to get in contact with British radio amateurs already using the BBC Micro for coding/decoding both CW & RTTY. Many thanks in advance.

I. Beng
BBC Micro Club – Tenerife
PO Box 1297
Santa Cruz de Tenerife
Canary Islands, Spain

COPESTAKE'S MISTAKE

Sir, Thank you for your letter and £20 cheque for my 'auto-destruct' tip in April's Beeb Forum.

However, since submitting the tip I have discovered certain situations where it doesn't work. I would be grateful if you would therefore publish an amendment.

Line 20 should read:

```
20 DIMP%6:?514=P%:?515
  =P%DIV256:COPT0:LDA#124:
  JSR&FFF4:RTS:]*K.10 1:lM
```

Line 30 should read:

```
30 REPEAT PROCx
```

There are also three places where l is printed as I.

Ian Copestake
Surrey

And our thanks to you for pointing this out so promptly.

EPROMS SAVE RAM

Sir, I have recently noticed adverts for EPROM programmers. Could you please explain what I can program onto these: can the programs be in Basic or assembler? If I can put my own programs on them, can they be slotted into the PCB? I would be grateful if you could explain my questions.

Colin Rice
Merseyside

EPROMs – erasable/programmable ROMS – are chips which can be used to store programs, rather than using up RAM. They can be re-used, and function as temporary ROM – for example with the BBC micro's 0.1 operating system.

Both machine code and Basic programs may be burned into EPROM and plugged into the empty sideways ROM sockets on the front right of the main circuit board. For either sort of program, special information must also be placed into the EPROM to inform the micro of the presence of the chip. Details of this format information are available from Acorn at Fulbourn Road, Cherry Hinton, Cambridge CB1 4JN. Tel: 0223 245200

SOUNDS SIMPLE

Sir, I have been following, with interest, the correspondence in *Acorn User* on the subject of audio connections to the BBC micro. Your reply to the lost chords letter in the February edition has finally incensed me to put printer to paper.

If, like me, your writer owns a model B which has no PL16 then the replies given by you only serve to increase the frustration.

My model B has the marking PL16 on the left hand edge of the PCB but there is no plug or socket connected to the board. Is the external connection supposed to go here? Could Acorn give us connection details for the two pads on the PCB so that we can make our own PL16?

A. Turnbull
Netherlands

PL16 doesn't need a plug or a socket. Simply solder a wire to each pad (one is ground and the other is the audio output) and connect to the tape input of your hi-fi.



SIGHT & SOUND

Sir, Several readers have commented about the need for better quality sound reproduction and higher volume, but the solutions offered, whilst bringing some improvement (eg larger/better quality speaker or use of the cassette recorder's amplifier) do not really provide a satisfactory long-term answer.

I feel sure that it should be possible to channel sound through the television itself, where there is ample volume and quality, and from where, naturally, one expects the sound to come. Such an improvement would enhance the already spectacular performance of the BBC micro, as I'm sure most readers would agree.

B. Sharrock
Bolton

There is a technical problem in sending a sound signal to the TV, because it has no separate audio input socket. This means the sound signal would have to be combined with the vision signal by replacing the existing modulator in the BBC micro (that tin box in the far right corner of the circuit board). However, the new modulator would have to be exactly the right type, and much bigger than the existing one – consequently, it would be difficult to fit.

A far simpler and better solution is to connect the Beeb's audio output to an hi-fi amplifier and through a set of speakers, as explained elsewhere in this section.

AMBER BOOB

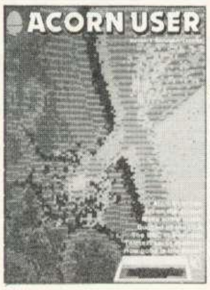
The Amber printer graphics dump of February's issue should be amended to read:

```
1019 REM send carriage return
     to clear paper
1020 VDU1,13,1,13,1,13
1039 VDU1,13,1,13,1,13
```

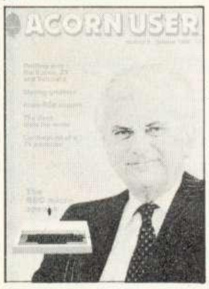
BACK ISSUES



July/August The first issue. Articles on drawing techniques, the BBC Computer Programme, machine code graphics, questions and answers, hints and tips, sound, interfacing scientific instruments, dumb terminals for 0.1 machines, disc drives, Econet in schools.



September Ceefax telesoftware, Beeb in business, mailing list, simple files, 30-Hour Basic course, art on a micro, music, BBC micro as a keyboard, extra Atom commands, BBC Basic board, ULA design, teletext graphics, machine code graphics, analogue input, schools training, 0.1 cassette bug patch.



October Electron details, BBC TV series – confessions, two Epson graphics dumps, Seikosha GP100 dump, Worldwide networking for BBC micro, garbage handling, voice ROMs, sound pitch envelope, moving graphics, ZX printer for Atom, RGB colour separations for Atom, biofeedback, book reviews.



November Teletext, second BBC TV series, machine code series 1, programming forum, Trek III, speeding up graphics, Bomber game listing, 7-tone Epson graphics dump, Atom graphics manipulation, dumb terminal for 0.1 machine, firework graphics, editing tips.



December BBC TV in schools, machine code 2 – registers, programming forum, program generators, carols, hints and tips, Logo and turtle graphics in schools, introduction to procedures, software review, Atom word processing, toolbox review, 16-colour graphics on model A, sorting, sound envelope design.



January MEP school launch, *FX commands for sound, second BBC TV series, machine code 3 – two pass assembly, disc drives for the Beeb, programming forum, program protection, micros in schools – new series, Commodore Pet printer used with Beeb, BBC programs written on an Atom, extra Atom memory.

BACK ISSUES of these magazines are available (except July) for £1.25 each from BKT (address below), which includes postage. Please make cheques payable to Addison-Wesley Publishers Ltd. For the July/August issue, we offer a photocopy service (see right).

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AU10

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Microtype will allow you to teach yourself, and will progress as you improve. Just a few short sessions and you will see results. Keep at it for say half a hour a day and you will be touch typing within a week, with no need to look at the keys ever again! Keep at it and speed will follow.

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At the start you will be given the 'home' keys to practice, but unlike normal typing tutors, the computer can tell on which keys you are inaccurate or slow and so can give more practice on these keys whilst at the same time replacing those on which you are proficient.

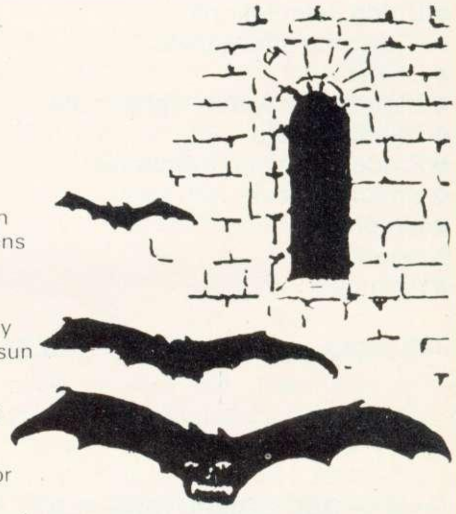
There is also the choice of practice mode or paragraph mode. So once the program has given, and you have learned, most of the keys, paragraphs can be attempted.

There are ten short exercises in each lesson, with a complete analysis of your performance at the end. This includes your average typing speed, accuracy and any keys you mis-keyed. If a response time is set, the program will also show the keys on which this time was exceeded. Being designed for micro keying, a great many of the words selected by the program are those which are actually used in programming the BBC. But of course, it is also ideal as a normal typing tutor, as both typewriter and computer keyboards are the same.

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If you have played adventures on other micros, you will find this one exceptional, and if you have never played an adventure before, it will get you hooked – try it . . .

HELP! If you get absolutely stuck with Dracula Island, give our adventure expert, Jan Green, a ring – she'll help!

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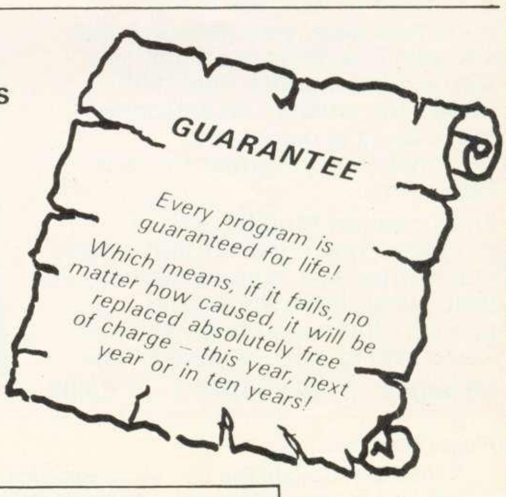
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HUMBER MICROS

The **Hull and District TRS80/ Beeb Users Group** meets twice monthly at the psychology department of Hull University at 8pm. Second Tuesday of the month is a talk or demonstration and the Thursday 16 days later is for members to do their own thing. For further information contact R. Souter (0482 654117) or J. Lawrence (0482 493856).

ESSEX NAMEBUG

Attention Beeb users in Essex. The **North and Mid Essex Micro User Group (Namebug)** has been formed to provide talks and demonstrations by local dealers and workshop evenings for help with mods, upgrades and interfacing. They meet at 7.30 on the second Thursday of each month in Witham. For details phone (after 7pm) Nigel Ballard (0206 72889), Dave Watts (0245 358127) or Andy Purkiss (0376 515609).

BEEB DOWN UNDER

We are very pleased to hear from the **Australian Beeb and Atom User Group** which is run from Canberra by Steve McLeod (address below). Good on you, Steve, we wish you lots of fun and hope others will follow your lead.

UNIVERSAL CORBY

Peter Wilson is the man to contact if you are a micro user (Beeb, Vic, Pet or Spectrum) in and around Corby. The **Universal Micro Club** meets fortnightly at the Spread Eagle in Oakley Hay. Details from the address below.

HELP WANTED

Would anyone wishing to help set up an Acorn User Group in the Wimbledon area please contact Mr A. Quinn, 19 Victory Road, London SW19.

CLUB CONTACTS

● Rupert Steele
Amateur Computer Club
St John's College
Oxford OX1 3JP

● **West Midlands Computer Group**
12 Apsley Road
Oldbury
West Midlands B68 OQZ

● Mr J. Price
Bedford House
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Norwich Area Acorn User Group
Room 12a, Norwich City College
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London N7 8DB

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● E.R. Piper
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Aldwick Park
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Sussex PO21 3RY

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Bottisham Acorn User Group
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